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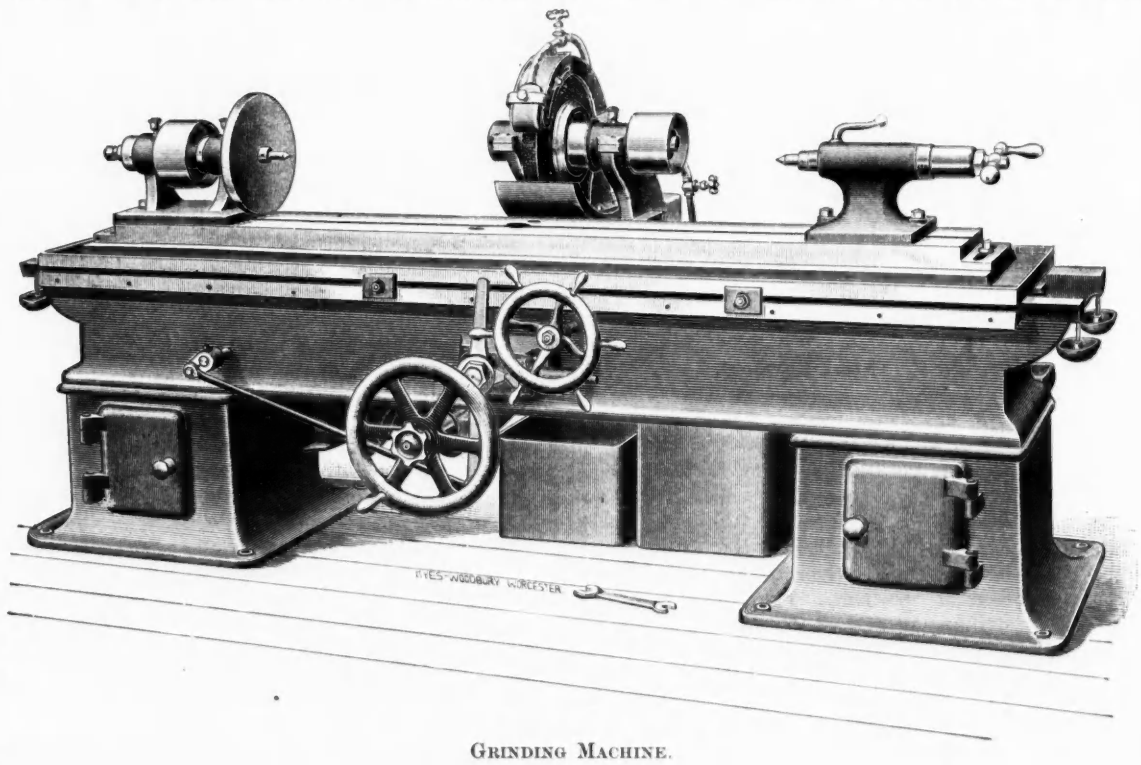
Large Spindle Grinder.

We give on this page an illustration of a machine intended for finishing cylindrical or tapering work by grinding upon centers. The machine consists essentially of a heavy bed, 102 inches long, supported on pedestals, which form closets for keeping fixtures. Upon this bed is mounted a platen, which is moved back and forth by suitable gearing in the same manner as a planer platen, sliding upon flat ways, which are provided with pockets for holding lubricants. Upon this platen is mounted a swinging plate, which is pivoted at the center and clamped at each end so that the head and foot-stocks which are mounted upon it can be swung around to grind taper work. The platen is gibbed to the bed in such a manner that wear can be taken up, and its movement is regulated by adjustable stops in front, as shown. Bolted to the back of the bed is the support for the carriage which carries the emery wheel, this carriage being fitted to move to and from the work by a hand-wheel in front and upon gibbed slides. A jointed hood covers the wheel, which is adjustable to the size of wheel used, and prevents the flying of water, which it is designed to use liberally, suitable channels being provided by which it is returned to a tank placed under the machine, from which it overflows to a second tank, whence it is drawn out by a centrifugal pump and again supplied to the work. The particles of emery and metal held in suspension by the water have time to settle in the first tank, and as the water overflows from the top of this to the second tank, which is smaller, clean water is secured.



GRINDING MACHINE.

The main spindle is fitted with taper bearings, which are adjustable to compensate for wear. Work may be ground on dead centers when desired. The diameter of the head-stock spindle is $1\frac{3}{4}''$; emery wheel spindle, $1\frac{1}{2}''$. Emery wheels up to $16''x1\frac{1}{2}''$ can be used. The machine takes in work 54″ long between centers, and swings 12″ diameter, its weight being 5,300 pounds. Other sizes of the machine are also made by the Springfield Emery Wheel Manufacturing Company, of Bridgeport, Conn.

A Chicago judge has decided that there are rights that a workman cannot barter away. A manufacturer executed, for the consideration of one dollar, a writing to the effect that a workman in his employ should not go into the same business in any one of nineteen States that were mentioned until at least three years after leaving the employ of the said manufacturer. The workman left and went into the same business, when his former employer attempted to stop him by injunction. The judge decided that the sum of one dollar and work for one week could not be held as sufficient in equity to restrain a man from earning a living, and he dissolved the injunction.

The Modern Steam Plant and its Management.

BY PETER H. BULLOCK.

THE IMPORTANCE OF LITTLE THINGS—MAKING USE OF OTHERS' EXPERIENCE.

In the articles that have appeared under the above title, the writer has discussed in a general way the care of a steam plant as usually found, and the different parts of which such a plant is composed. Before following the transmission of the power from the engine to the shafting, and from thence to the machines where it is employed in useful work, it is my intention to recall some of the little things in each of the several processes between the time the fuel is put into the furnace until its energy is made manifest in the revolving fly-wheel.

We are told not to "despise the day of small things," and it is a proverb that, if we look after the pennies, that the dollars will look after themselves. As applied to the care of steam apparatus, it would mean that a man who would look after all the little details would never allow any large defects to exist. It is also a proverb that it does not pay to "save at the spigot and waste at the bung;" or for us, that it does not pay to sift 10 cents worth of coal from the ashes, and lose a dollar by neglecting some more important duty; or to save a few drops of oil, and wear or melt out bearings worth enough to buy oil for a year. I once knew a railroad master mechanic who was always picking up stray nuts and bolts—a very commendable thing to do—but the directors thought that this work could be done as well with common as with skilled labor, and his successor devoted his energies to keeping up the engines, and left the collection of junk to the section and yard bosses.

In this resumé I will follow the different operations in their regular sequence, the burning of the fuel being the first, and every man in charge of a boiler or steam plant may consider what is said to be addressed to him.

You should study the best way of firing the boilers under *your* charge, considering the peculiar conditions or construction, if any there be, under which you are obliged to operate them. Do not try to force any previous experience, that may have been under far different conditions, to fit your present surroundings, but try different methods, note the results, and adopt the best as it appears after trial. Carefully weigh the fuel under different conditions; see how much you burn in a week when you do not clean the flues or other fire surfaces of your boiler, and then see how much you save by performing that necessary operation once or twice. Watch the combustion and the effect of more or less air admitted through the fire-doors or other prepared places over the fuel; see whether a thick or a thin fire best suits your draught, and whether you produce large volumes of black smoke when burning soft coal, and if so, try different ways of firing to prevent it. In cleaning the fire, do not get good coal mixed with the cinders and sent to the dump. There is a lump of coal in your clinkers weighing but a pound and a half, yet it can be made to develop a horse-power for an hour, or energy enough to elevate a 200-pound engineer 9,990 feet high in an hour's time, if with lots of other pounds and a half the different events and processes are carried out in a large plant especially designed for economy. Here is a suggestion for each engineer: Figure up how high a pound and a half of coal would elevate the above mentioned heavy weight as burned under *your* boilers. This is plain arithmetic, and every man can do it. If you have not got all the necessary data as to fuel burned and horse-power indicated, it is time that you should have it. It will only be necessary for you to convince your employers that it is for their pecuniary benefit for you to know these things that they may profit by your knowledge, inasmuch as it will enable you to perform your duties more intelligently.

After properly burning the coal, the next thing is to see that as much of the heat as possible is absorbed by the fire surfaces of the boiler and transmitted through it to the water inside. Remember that clean metal transmits heat very quickly, but that a small amount of dust outside, or of mud or scale inside, will retard the transmission of the heat wonderfully. Try this experiment: Take a small metal dish, and put into it a half pound of water, and see how long it will take to bring it to a boil over a kerosene or gas heater; now, without changing the blaze, smear the dish over with lampblack from a smoky burner, and see the difference in time it will take to bring another half pound of water to the same temperature. This will represent the dust and soot on the outside of a boiler. Now, take and cover the inside of the dish with a coat of paint or varnish, and try another half pound. This will represent an oily deposit or scale on the inside of a boiler. This internal coating is often so thin that it escapes unnoticed, except the searcher is experienced in such matters. These are little things in themselves, but their importance and effect in the economical management of a steam plant are by no means to be classed as such.

In the different ways of supplying a boiler with water, various chances may be found to make savings that will aggregate a good deal in the long run. There may be drips from steam apparatus that are allowed to go to waste, but which might be saved by some simple pipe connection. Heat saved is as good as heat generated, but care should be taken that the drip is not mixed with animal oil or chemicals, for these might do more damage in a few days than the savings would amount to in a year. Not long since it was reported to me by an assistant that the water in a set of boilers had suddenly turned black, and a hasty examination showed this to be so. As continued pumping and blowing did not seem to affect it, and as I was ignorant of the cause, I ordered the fires covered with wet coal until we could find out what was the cause and effect of this inky injection. About this time the foreman of one of the departments came in and complained that he had by some means lost a 100-gallon tank full of staining material, composed principally of concentrated potash and extract of logwood. One of the copper pipes for heating the tank had burst, and when steam was shut off the liquid had been finding its way through regular pipes to our hot-water tank from which the boilers were fed. I am not ready to recommend this as a boiler compound for general use, but will say that in the diluted but high colored state in which it got into the boilers, it did no harm. It was simply a little startling to see things cloud up so suddenly. We don't save that drip any more.

A leaky valve or steam pipe may not be thought to be of much consequence, still it does not take much of a leak to pass 100 pounds of steam and water in a working day. The valves or piston of an engine may

not leak but a little each stroke, but the average engine nowadays gets in a good many of these strokes in ten or twelve hours, and the combined volume of these thousands of little puffs would surprise you if the wasted energy could be made manifest in a single effort. Steam clearance in an engine is a necessary evil, and as builders usually provide it with a liberality to be regretted, it is unnecessary to increase it by attaching an indicator pipe with a three-way cock in the center. There is an engine in Massachusetts of 4-feet stroke that runs 80 revolutions per minute under 90 pounds of steam, that has such a pipe, which has been in place 12 years. Let us see: $80 \times 60 \times 10 = 48{,}000$ revolutions per day. We will call this pipe an engine by itself with a piston area of .196+ inches, a stroke of four feet, and a M. E. P. of 14 pounds, which was what the main engine showed, and as this imaginary engine has the full size of its cylinder for port area, it is fair to call its M. E. P. the same as that from whence it gets its steam supply. Here we have a half horse-power engine running all the time, that we may get a more or less imperfect indicator diagram once in a while. A little thing, to be sure, but the energy is worse than wasted, inasmuch as the object for which the pipe is there can be better obtained without it.

Not long since I chanced into a small manufacturing place where the engine was running quite badly, and it was evident that, in addition to some looseness of parts, that the eccentric or valve was out of its proper position. This opinion was given to the person in charge, in answer to his question, of what I thought "made her thump so." He thought that this could not be so, as he had moved it several times himself, and it had done no good. How much did you move the eccentric? About an inch on the shaft. Let us see what he had done. The shaft was 20″ in circumference, and an inch on that is equal to 18 degrees. Quite a move for an engine eccentric, which has got to be mighty near one place in order to distribute the steam correctly. That one place was found, and you could not move it one degree either way and have the engine run as well. You have a crank-pin that runs quiet and cool, drive the key $\frac{1}{16}$ of an inch, and it will heat, back it the $\frac{1}{16}$ of an inch, and the brasses will click. Center the piston and crosshead just right, and see how straight and even the rod passes through the gland, but let either of them get out line, and notice the result. There will be a visible springing movement, and a slight leakage of steam at each inward stroke. You see by these things the mechanical importance of small adjustments, and there is a very close relationship between the mechanical and the financial results of small changes in the parts that go to make up a steam plant. An engine may run badly for want of proper cushion, which a slight change in the valve gear would provide, and such change would result not only in a better running engine mechanically, but the necessary cushion may be secured by a compression of a portion of the exhaust, and the engine actually use less steam for the same work than before the adjustments were made, and all this double acting improvement is brought about by very slight changes. Surely it will not do for an engineer to despise or neglect *little things*.

When erecting or operating steam apparatus, it is well to follow the directions given by the builders, for although it may sometimes do to depart slightly from them, it will be found that, as a general thing, the directions given are founded on experience, and each little detail has a good reason for its requirement. There has been many an excellent piece of apparatus condemned from neglect in following the directions given for its setting up and management. A machine in which compressed air was used was sent to a distant State, and among the directions for putting it together was this: "Be sure and use the stud with air-hole in it on the round air cap *A*." As this was plain English, and the other caps were square, it was thought that there could be no mistake, but there was, and the machine was broken. Loss of freight, $8.40; broken parts, $4.10; time, two weeks; patience and use of strong language, ? ? ?; all because somebody didn't read and ponder.

I was once sent to put up an injector, and one of the directions said: "Do not attach to pipe used for other purposes, but tap top of boiler or main steam pipe for supply." The parties did not want any holes drilled into boiler or pipe, but wanted it attached to a pipe intended for a drip on the bottom of an elbow in the 6″ steam pipe. I protested, but they said "there or nowhere." It was put on as they wanted it, but it did not work at all satisfactorily, and the shop got a notice to make it work or take it out. I told the foreman what the matter was, and he said: "Well, Pete, we must humor them; let 'em think they are having their own way, but accidentally break that nipple in the elbow, and put in its place one of those lock-nut nipples that we use on column radiators." The suggestion was followed, a piece of scale was found (?) in the steam passage, the nipple got broke and replaced by one I happened (?) to have with me, and there was a good working injector, and everybody was happy. If any interested parties in a smart town in R. I. recognize these circumstances, and ever have occasion to take down that pipe, they must not get discouraged, for it does not extend up into that elbow over four inches. All is well that ends well; but I ought to have connected it right in the first place, for the makers of the injector knew its defects as a water motor, and had given explicit directions for getting dry steam.

I hope that these reminiscences of trivial things may impress on the minds of my readers the fact that success in engineering often depends on some very small things or obscure conditions, and that he who best applies his energies will the best succeed. An engineer's duties consist of applying and putting into effect his attainments, which are, or should be, of a varied and complex character, the different parts of his business touching almost every branch of applied science. As the myriad improvements in the generation and transmission of power follow closely in the wake of scientific researches and mechanical perception, so must the ability to manage these great forces and powers keep abreast of them all, and there is no doubt but that the remuneration for such services will bear a proper relation to the skill and ability required to manage them.

Steel Rowboat.

A small steel rowboat has recently been completed for the Universities Mission in Central Africa. The following description of the same has been taken from *Industries*. It is 14 feet in length by 4 feet beam, and is built of galvanized steel. It is made in three sections, to take to pieces for ease of transport. The keel, stem, and sternpost are of steel, the seating and thwarts of teak, and the floor boards of pine. The garboard plating is No. 14 B. W. G.; and above that No. 16 B. W. G.

The frames are $\frac{3}{4}$ inch by $\frac{3}{4}$ inch by $\frac{1}{8}$ inch, spaced 1 foot 2 inches apart. There is india-rubber packing $1\frac{1}{8}$ inch by $\frac{3}{16}$ inch between the joint frames, which are $1\frac{1}{8}$ inch by $\frac{3}{4}$ inch, bolted together with $\frac{5}{16}$ inch bolts. The plates are lap-jointed, and single-riveted with $\frac{5}{16}$ inch rivets, and are full length of each section. The thwarts are fitted with galvanized iron knees. The weight of the boat is about 560 pounds. It is to be used as a tender to the larger vessel, which was constructed to the order of the society in 1887, and which is now in use on Lake Nyassa.

This mode of building boats and frames in section is of considerable value for export purposes, as it not only effects a saving in freight, but allows the boats to be readily conveyed overland to inland waters.

Every one who at all appreciates the genius and services of John Ericsson will rejoice to know that, so long as his body is to be removed to his native land, it is to be taken there in one of the best of our modern naval vessels and with every possible honor. It will be an honor most worthily bestowed.

Odontics, or the Theory and Practice of the Teeth of Gears.

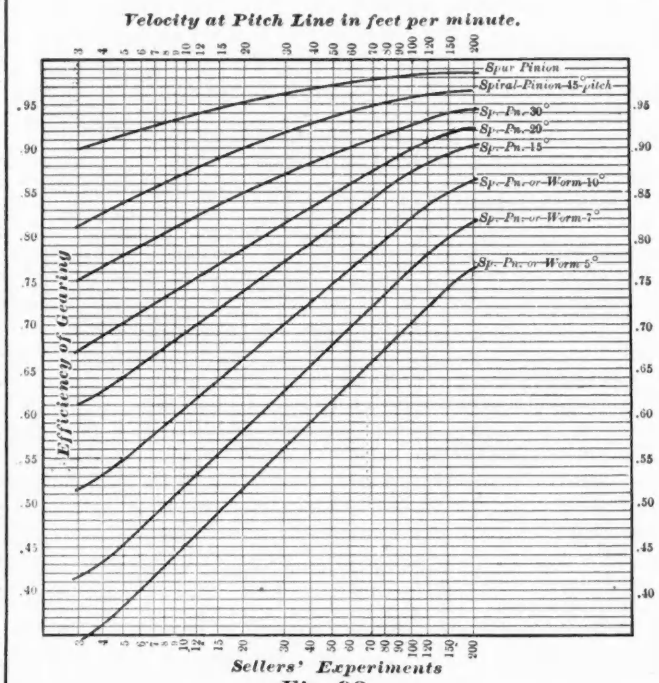
By Geo. B. Grant.

ELEVENTH PAPER.

(*Worm Gears Continued.*)

112.—EFFICIENCY OF SPIRAL AND WORM GEARING.

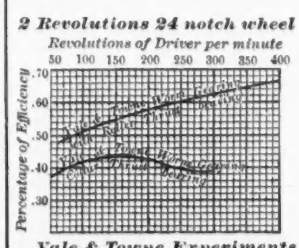
Unless the shafts are parallel the teeth of a pair of spiral gears are moving in different directions, and therefore they cannot pass each other without sliding on each other an amount that increases rapidly with the angle of divergence of the directions of motion, that is, the shaft angle.



Sellers' Experiments
Fig. 93.

This sliding action creates friction, and tends to wear the teeth, and to a very much greater extent than is generally supposed. The friction is so great, in fact, that such gears, particularly worm gears, should be used only for conveying light powers. They are extensively used, or rather misused, for driving elevators, and are even found in milling machines, gear cutters, planers, and similar places, in evident ignorance that they waste from a quarter to two-thirds of the power received.

The most extensive experiments on the efficiency of spiral and worm gears ever made were made by Wm. Sellers & Co., and they may be found described in great detail in a paper by Wilfred Lewis in the Transactions of the American Society of Mechanical Engineers, vol. vii. Space will not permit extensive quotations from this valuable paper, but the general result of the experiments is shown by the diagram, Fig. 93. The diagram shows that a common cast-iron spur gear and pinion on parallel shafts have an efficiency of from ninety to ninety-nine per cent., according to the speed at which they are working; that a spiral pinion of 45°, angle working in a spur gear, with shafts at 45°, has an efficiency of from 81 to 97 per cent.; that the efficiency decreases as the angle of the shafts increases, until, for a worm of a spiral angle of 5°, at a shaft angle of 85°, it goes as low as 34, and does not rise higher than 77 per cent. This includes the waste of power at the shaft bearings as well as that at the teeth of the gears. The efficiency is lowest for slow speeds, and rises with the speed. The diagram may be relied upon to give its true value, under ordinary conditions, within five per cent.



Yale & Towne Experiments
Fig. 94.

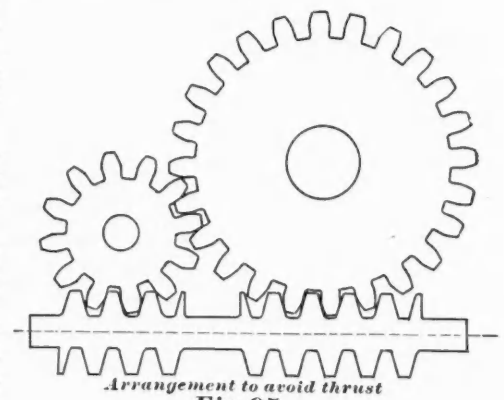
The same experiments developed the fact that the velocity of the sliding motion of the cast-iron teeth on each other should not be over two hundred feet per minute in continuous service, to avoid cutting of the surfaces. It may be assumed that the efficiency will be higher when the worm is of steel, particularly when the gear is of bronze.

Diagram, Fig. 94, shows the result of similar experiments by Prof. Thurston, with a worm of 6″ diameter and one inch circular pitch running in a gear of 16″ diameter, both cast-iron.

It is to be observed that it is the shaft angle, and not the angle of the spiral, that determines the efficiency. A pair of spiral gears on parallel shafts are practically as efficient as gears with straight teeth.

The great friction of worm gearing is of advantage for one purpose, and for one only, to secure safety and prevent undesired motion of the gears. The worm of Fig. 97 will easily move the gear, but the gear must be moved with great force to start the worm. When the angle of the worm is as small as the "angle of repose" for the metals in contact, it is impossible for the gear to drive the worm. This may be an excuse for the use of the worm gear in elevators, but it would seem that the safety of the cage should depend on devices attached to the cage itself, rather than to the hoisting machinery or other distant part.

Unless the friction of the gears must be depended upon for safety, the worm gear should be used only for purposes of adjustment, or when speed must be greatly reduced or power increased within a small compass, and not for conveying power.


Arrangement to avoid thrust
Fig. 95.

113.—THRUST OF SPIRAL TEETH.

The oblique action of the teeth of spiral gears on each other tends to throw the gears bodily in the direction of their axes, and this tendency creates a thrust that must be opposed by thrust bearings. The end pressure on the shaft of a worm is greater than that exerted on the teeth of the worm gear it is driving.

When the shafts are parallel the thrust may be completely avoided by the use of double spiral or "herring-bone" teeth, Fig. 82 or 83, which act in opposite directions, and neutralize each other.

When the shafts are at right angles the thrust may be neutralized by opposing a second gear in the manner shown in section by Fig. 95. The two worms with opposite spirals run in two spiral worm gears that also work with each other, and, as the pressure on one gear is opposite that on the other, there is no thrust on the shaft. When this combination is made with worm gears having concave teeth, the teeth can bear only at their ends.

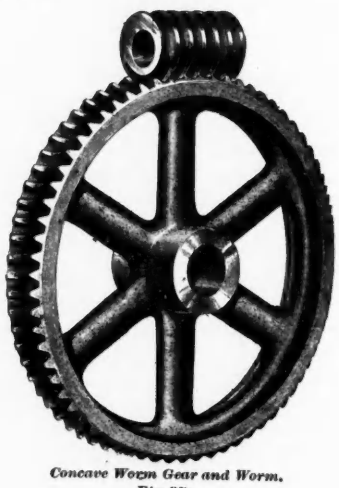
When the thrust cannot be avoided it should be taken by a roller bearing, rather than by the common collar bearing. The

diagram, Fig. 94, shows the superior efficiency of the roller bearing as compared with the collar bearing, the gain being from ten to twenty per cent.

114.—THE HOBBED OR CONCAVE WORM GEAR.

If a spiral gear is made of steel, provided with cutting edges by making slots across its teeth, and hardened, it will be a practical cutting tool called a spiral milling cutter or hob. Fig. 96 shows a spiral milling cutter, having a great spiral angle, and therefore called a worm. If this cutting spiral gear is mounted in connection with an uncut blank so that both are rotated with the proper speeds, and the shafts of the two gears are gradually brought together while they are revolving, the edge of the blank will be formed with concave teeth that curve upwards about the sides of the cutting gear. If the hob is then replaced with a spiral gear that is a duplicate of it, except that it has no cutting teeth, we shall have the familiar worm and worm gear of Fig. 97.

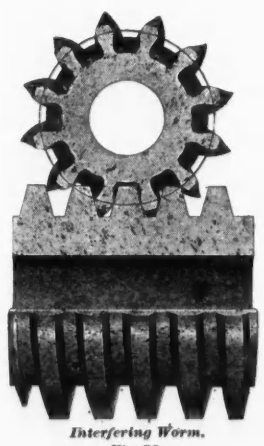
A Hob. Fig. 96.



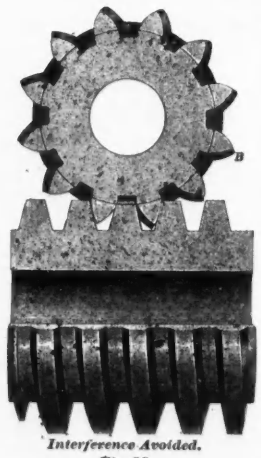
Concave Worm Gear and Worm. Fig. 97.

The principle of the concave gear applies to any pair of spiral gears, on shafts at any angle, but in practice it is confined to the worm and gear on shafts at right angles.

The nature of the contact between the worm and the concaved worm gear has not yet been definitely determined, but there is no reason to suppose that it is different from that between plain spiral teeth, a point contact on the normal spiral, but it is probably continuous. It is certain, however, that the contact is considerably closer, more nearly resembling surface contact, and being surface contact when the diameter of the gear is infinite.



Interfering Worm. Fig. 98.



Interference Avoided. Fig. 99.

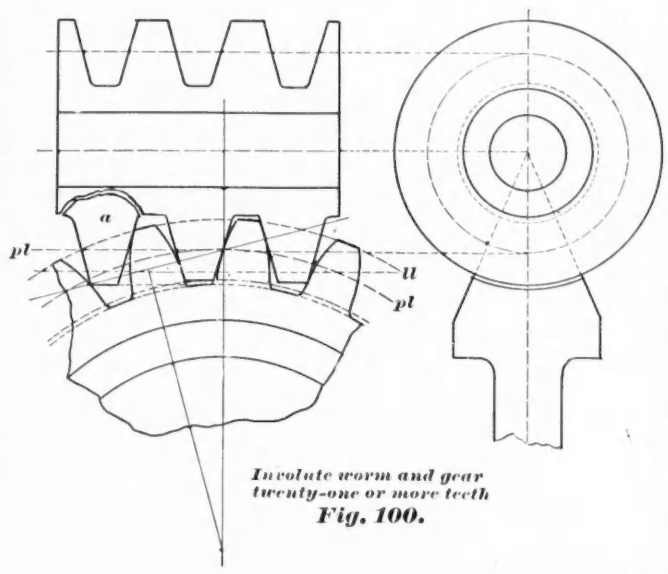
The worm is adjustable in the concaved teeth of the gear in the direction of its axis, and will change its position as required by the wear of the thrust bearing. It is not adjustable laterally.

115.—HOBBING THE WORM GEAR.

When the hob is provided it is a simple matter to cut the gear. The gear is generally provided with the desired number of notches in its edge, that are deep enough to receive the points of the teeth of the hob, and the hob will then pull it around as it revolves.

It is a too common practice to make the hob do its own nicking, for, if it is forced into the face of the gear as it revolves, it will pull it around by catching its last teeth in the nicks made by the first.

If luck is good these nicks will run into each other, and the gear will be cut with teeth that appear to be correct, but, as the outside diameter is greater than the pitch diameter, there will be one, two, or three teeth too many. The teeth of the finished gear are therefore smaller than those of the worm by an amount that is ruinous if the gear is small, although it is not noticeable when the diameter is large. If there are 12 teeth where there should be but 10, each tooth will be too small by two-twelfths of itself; but if there are 102 teeth where there should be but 100, each tooth is too small by but two-hundredths of itself. This handy makeshift process will do very well on large gears, but not on small ones, unless the worm to run in the gear is made to fit the tooth, with a tooth that is smaller, and lead that is shorter than that of the hob.



Involute worm and gear twenty-one or more teeth

Fig. 100.

116.—INVOLUTE WORM TEETH.

Worms are generally cut in the lathe, and as a straight-sided tooth is most easily formed, the involute tooth is generally adopted.

Strictly, the form of the tool should be that of the normal section of the thread, and it should always be set in the lathe with its cutting face at right angles to the thread. But custom and convenience allow the tooth to have straight sides, and to be set with its face parallel with the axis of the worm, and the real difference is not generally noticeable.

The standard tool has its sides inclined at an angle of 30°, and has a length and a width dependent upon the pitch.

117.—INTERFERENCE OF INVOLUTE WORM TEETH.

There is one difficulty that is seldom recognized, but which must be carefully guarded against if properly running gears are expected, and that is interference. The teeth of worm gears will interfere with each other when the conditions are right for interference, just as spur involute teeth will interfere, as shown by Fig. 36. Fig. 98 shows the gear that would be formed by the usual process. The difficulty can be remedied by rounding over the tops of the teeth of the hob and worm, as described in (55).

It is also a simple matter to avoid the interference by enlarging the outside diameter of the worm gear. If, as shown by Fig. 99, the tooth has but a short flank, or none at all, and the addendum of the gear is about twice that by the usual rule, the action will be confined to the face of the gear and the flank of the worm, and there can be no interference. By adopting an obliquity greater than 15°, interference can be avoided without changing the addendum.

This method has the advantage that the same straight-sided worm and hob can be used for small gears as for large ones, and the disadvantage that the action is confined to the approach and subject to greater friction (48).

When the standard 30° tool is used, all gears of 26 teeth, or smaller, should be made in this way, but the correction is not strictly necessary for gears of more than 20 teeth, unless particularly nice work is required.

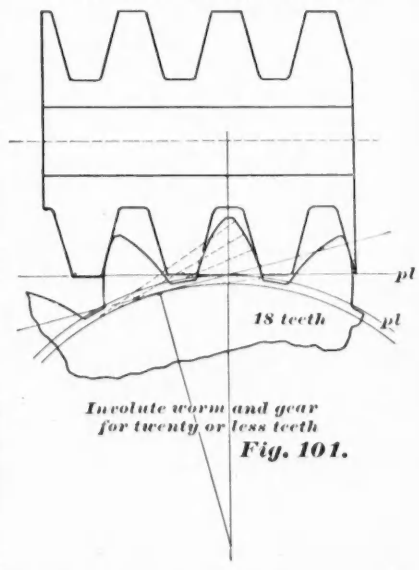
Fig. 100 shows the proper construction of a gear of 21 or more teeth, and Fig. 101 shows that of a gear of less than 21 teeth. In the former case, the teeth of the worm should be limited by the limit line *ee*, but the interference for 21 to 25 teeth is not noticeable.

118.—CLEARANCE OF WORM TEETH.

There is another practical point that is seldom recognized, and that is that worm teeth should have clearance (40), for there is no reason for clearing spur teeth that will not apply quite as well to any other kind.

The clearance is easily obtained by making the tooth of the hob a little longer than that of the worm, as shown by the tooth *a* of Fig. 100. For the same reason the hob should have no clearance at the bottom of its thread, so that the tops of the gear teeth will be formed of the proper length. The custom of making the hob and worm of exactly the same diameters will apply only when the worm "bottoms" in the gear and the gear bottoms in the worm.

Draw worm teeth straight
Draw gear teeth by points (57)



Involute worm and gear for twenty or less teeth

Fig. 101.

Thick and Thin Furnace Plates.

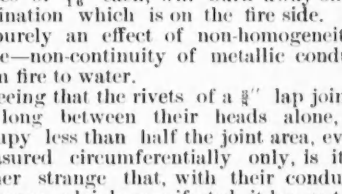
BY W. H. BOOTH.

Constructing engineers are proverbially conservative. To this may be attributed the continued thinness of furnace plates. I confess to a weakness for a thin furnace plate myself, but can see no reason why thicker plates than ordinarily employed should become burned *if properly arranged and used.*

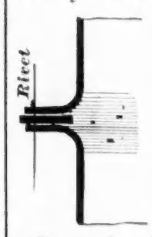
There is a powerful argument for thin plates in the example of the locomotive. The plates of a locomotive fire-box are supposed to burn away to ⅜ thick if they start at a greater thickness than this, but are we to take it that such plates have had a fair chance?

Will any advocate of thin plates undertake to state positively that the narrow water spaces of the locomotive fire-box are not filled with mere foam, and not with solid flowing water? Are not the advocates of thick plates quite right in saying that, given solid water, a fire-box even of a forced draught furnace, such as that of a locomotive, may well be made of ⅜″ plate and not burn out?

So far as my own experience goes, the cause of plates burning is want of quenching contact on one side. Foam is not a good quencher, and so plates burn thin if exposed



to foam and not to water. It is not altogether clear for all that why they do not continue to burn thinner than the ⅜″, which is so generally stated as their limit. The original reason for thin plates in furnaces on this side the Atlantic is the fact that, as I have already stated in these columns, lap joints of ½″ plates always burn at the overlap, the plate cracking between rivet hole and edge of plate; that $\frac{7}{16}$″ plates lap-jointed and exposed to fire often crack in the same way, but frequently do not crack, whilst ⅜″ lap-jointed furnaces rarely do crack.



From this it would appear that the two plates at a lap joint not being joined in clean metallic contact are more easily burned than if solid.

We see, however, that two riveted plates of a combined thickness of ¾ inch will not burn so long, as at two inches pitch a rivet, tightly driven, extends as a solid piece from fire to water. The rivet saves the whole joint by its good conductivity.

Clearly it is the rivet which does this; for a laminated plate only ⅜″ thick, in two thicknesses of $\frac{3}{16}$″ each, will burn away on that lamination which is on the fire side. This is purely an effect of non-homogeneity of plate—non-continuity of metallic conductor from fire to water.

Seeing that the rivets of a ⅜″ lap joint are ⅜″ long between their heads alone, and occupy less than half the joint area, even if measured circumferentially only, is it not rather strange that, with their conducting power so plainly manifested, it has not been sooner attempted to use ⅜″ and 1″ plates for high pressures? Lap joints being non-homogeneous are always liable to burn sooner than solid plate, and hence the Adamson flue jointed as in Fig. 2, which offers nowhere but a single thickness of plate to the fire action, and which is now so nearly universal.

Had steam pressures been as high when this seam was invented as they now are, it would have been recognized as a means of securing safety in using thick plates, but we have gone on so long using flues of ⅜″, and amply strong enough for their duty when reinforced with flanged seams every thirty inches, that any further thickness has come to be looked on with suspicion, and no one has been courageous enough to use it. Are corrugations then unnecessary? and are they to be classed with the cogged wheel for locomotives, which were used at first under the belief that smooth wheels would slip? or is it possible that the corrugations are of use in increasing the area of absorbing surface of the furnace plate?

After the hold obtained in marine work by the corrugated furnace, it would be rather odd to see a return to plain furnaces. There is, however, the question of weight. Corrugating saves probably half the material which would go to form a sufficiently strong plain flue, and this is a big order in itself; and when corrugated patent rights have run out a corrugated furnace will be cheaper than a plain furnace of equal strength. As regards the greater liability of the corrugated plate to adhere to scale, there is a good deal to be said on the desirability of using purified water in steam boilers, and leaving the scale outside.

So far as regards strength, it must always appear more scientific engineering to use that flue tube which gives the needful resistance with least material, whether such resistance be got by corrugating, by using Brown's ribbed plates, or by the flanged seam in place of mere brute thickness. It is akin to the difference between a solid rectangular beam and a girder of ▌ section; but one can imagine boiler constructors using thick plain furnaces if these come in cheaper than the more scientific thin one. In the long run, however, the furnace which has least weight per standard resistance will, other things being equal, come in first.

At the same time there seems no objection, when solid water exists on fire side of a plate, to this plate being an inch thick.

The Vesuvius and Her Armament.

BY M. W. SEWALL.

FOURTH PAPER.

Figs. 6 and 6 *A* show a longitudinal section of the discharge valve and a transverse section of the auxiliary valve at the air passage connecting the exhaust chamber of the former with the exhaust throat of the latter—the same passage also serves as a filling port when the auxiliary is closed.

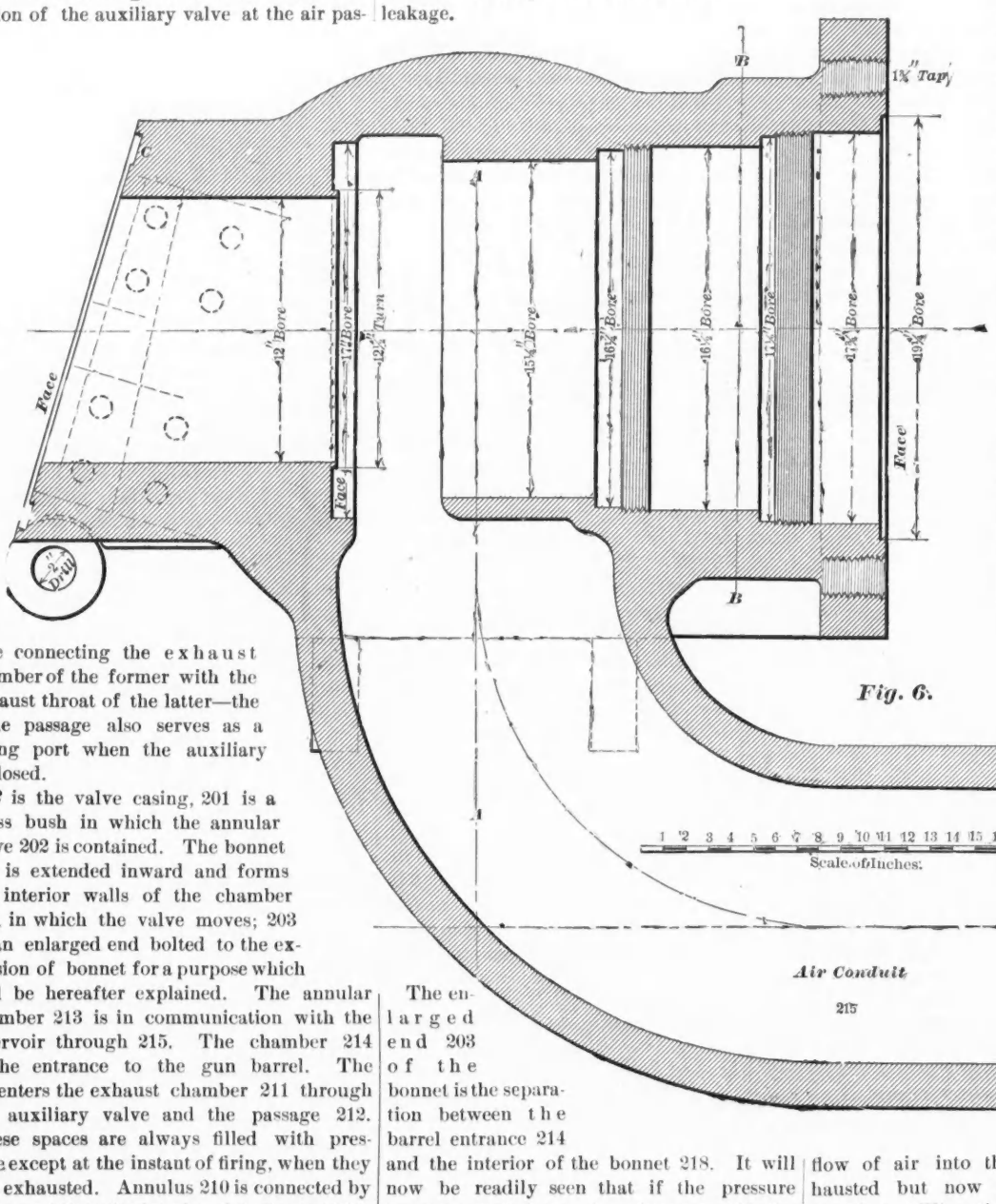


Fig. 6.

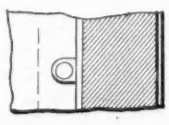
B is the valve casing, 201 is a brass bush in which the annular valve 202 is contained. The bonnet 200 is extended inward and forms the interior walls of the chamber 211, in which the valve moves; 203 is an enlarged end bolted to the extension of bonnet for a purpose which will be hereafter explained. The annular chamber 213 is in communication with the reservoir through 215. The chamber 214 is the entrance to the gun barrel. The air enters the exhaust chamber 211 through the auxiliary valve and the passage 212. These spaces are always filled with pressure except at the instant of firing, when they are exhausted. Annulus 210 is connected by passages 209 to the interior of the bonnet 218, in which atmospheric press is always maintained. The area of the valve exposed to atmospheric pressure in 210 is marked 220, and is called the closing shoulder of the valve. The small annular chamber 216 on the outside of the valve is always exposed to the full reservoir pressure, and is called the opening shoulder and marked 217. 206 is a hydraulic packing which prevents the air from passing from 211 to 210. No packing is used on the outside of the valve, because the chamber 211 is exhausted but for an instant, and provision can readily be made for the leakage.

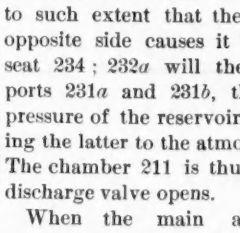
The enlarged end 203 of the bonnet is the separation between the barrel entrance 214 and the interior of the bonnet 218. It will now be readily seen that if the pressure be exhausted from the chamber 211 the valve will move back until it strikes the buffer 205—on account of the pressure on the shoulder 217, which pressure is constant. It is also evident that when the pressure is again restored to 211 the valve will close with a force due to the pressure into the area of the closing shoulder 220, and it will be held on its seat 207 by this force.

The length of time that 211 remains exhausted determines the time of closing the valve, or the cut-off of the air in the barrel.

The auxiliary valve, so-called, Figs. 10 and 12, consists of two valves, the primary 233 and the main auxiliary 232. The main auxiliary is automatic in its action, and is operated by the exhaustion and restoration of the pressure which holds it on its seat.

The primary, however, is opened by hand, and when the opening toe 241 (Fig. 12) is tripped it closes automatically, and immediately following its closure is the opening, first of the main auxiliary and then the discharge valve itself. The main auxiliary is closed by the restoration of the pressure on its full area caused by the uncovering of a port as it nears the end of its own opening stroke, thus permitting the inflow of air into the exhausted but now closed chamber. When the auxiliary is closed, communication between the chamber 211 and the atmosphere is cut off, while communication with the reservoir is re-established, and the discharge valve is consequently closed again. A detailed description of this valve will probably be necessary to its being fully understood.





Detail of Packing at C.

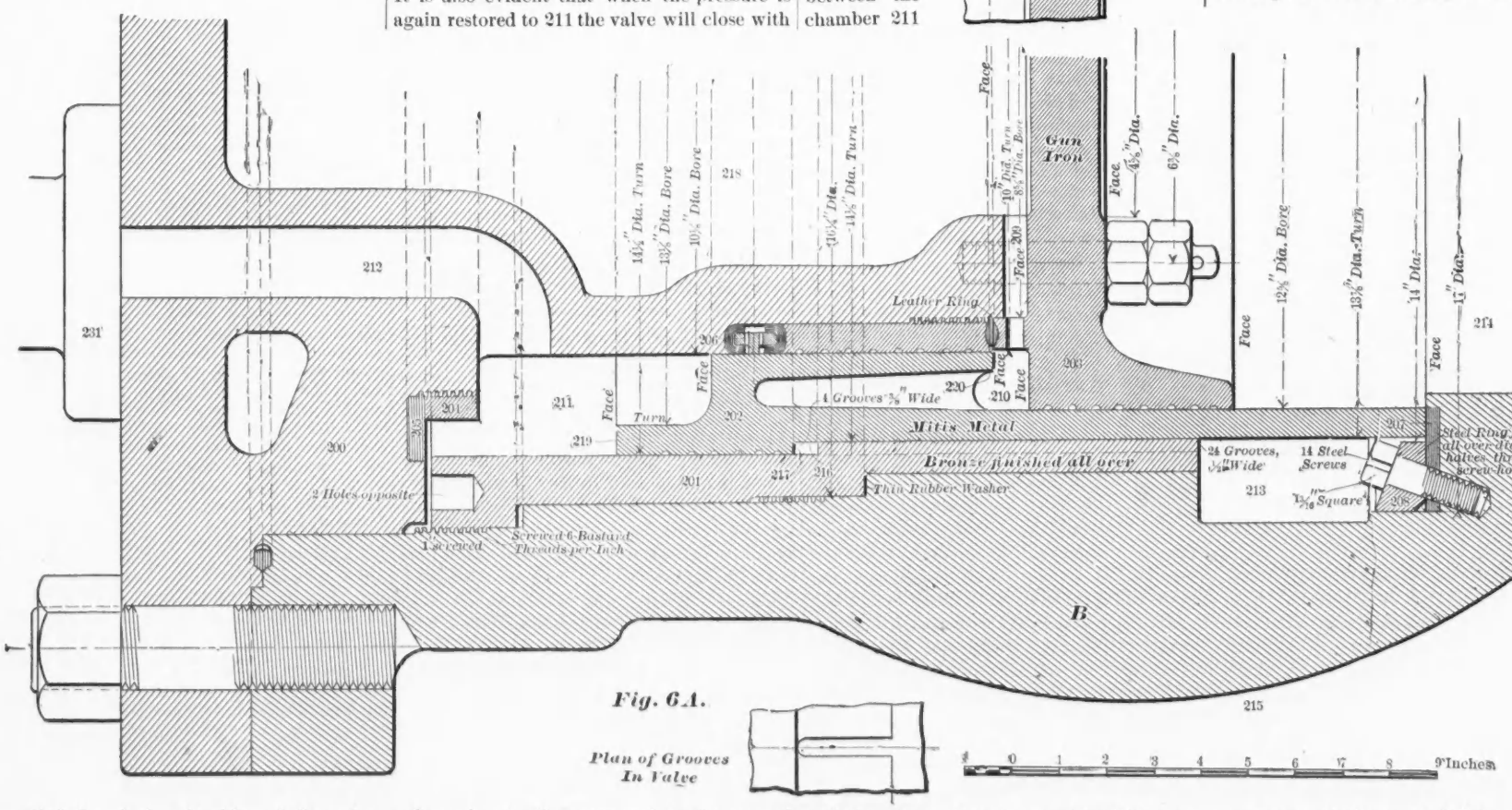
Fig. 7.

Figs. 10 and 12: 231 is the casing of the auxiliary valve, with a bush 231*a* forced into its interior; said bush has openings 231*b* leading to the annulus 222 and 231*c* to the annulus 224; 224*a* connects 224 to the constant pressure in the reservoir. The reservoir pressure fills, except at instant of firing, the whole interior of the casing 231 and of that of the primary valve. 221 connects 222 with 212, and by it to the exhaust chamber 211 of the discharge valve; 232 is the main auxiliary valve, and has its seat on the leather ring 235; 225 is the exhaust throat, through which the chamber 211 is exhausted when 232 is opened; 234 is a leather buffer to receive the shock of the main auxiliary 232 when it opens.

233 is the primary valve with its seat on the ring 237. 233*a* is an extension on this valve which enters the hole at the left of it and closes it when 233 is opened; 242 is the operating lever and 241 the trip toe by which the primary 233 is opened and then released.

The action is as follows: The operating lever is lifted up, this advances 241, and forces 233 off its seat and closes the hole to the left of 233*a*, thus allowing the air in 227 to escape, but trapping in the air in 226. On a further movement of the lever the tail of 241 comes in contact with the lever itself when the opposite end is forced down and off the stem of the valve, thus allowing the pressure on the port 233*a* to force it shut. The hole 236*a* is thus opened again, and the pressure in the chamber flows into 227, which is enlarged by the globe 243; the pressure is consequently reduced on the back of the valve piston 232 to such extent that the full pressure on its opposite side causes it to move back to the seat 234; 232*a* will then be between the ports 231*a* and 231*b*, thus cutting off the pressure of the reservoir from 222 and opening the latter to the atmosphere through 225. The chamber 211 is thus exhausted and the discharge valve opens.

When the main auxiliary valve 232 opened, it uncovered the port 228, and so allowed pressure to again flow into 227 through the regulator 230 (which is simply a small valve with a micrometer-controlling device), and passage 229. When the pressure is sufficiently accumulated here to overcome the pressure on the front of 232 it will immediately close. The closing of this valve again puts chamber 211 behind the discharge valve


Face
Gun Iron
Face
4⅝" Dia.
6⅝" Dia.
10" Dia. Turn
8⅝" Dia. Bore
14½" Dia. Turn
14⅜" Dia. Bore
10⅝" Dia. Bore
10¾" Dia.
14⅝" Dia. Turn
12⅝" Dia. Bore
13⅜" Dia. Turn
14" Dia.
15" Dia.
Face
Face
Face

into communication with full pressure 212, 222, 223 and 224, in consequence of which it is immediately filled and the valve closed. The regulator 230 is simply a throttling valve by means of which the flow into chamber 227 may be controlled so as to allow the main auxiliary to remain open a longer or shorter time. On the length of opening of this valve depends that of the discharge valve, and consequently the amount of air that is admitted into the barrel behind the projectile. A small quantity admitted will, of course, give a short flight, while a larger amount will act through a longer time and distance on the projectile at the maximum pressure, and proportionately increase the range.

Engineering Ignorance.

By W. K. Stevens.

At no previous time in the world's history has the advance in engineering knowledge and achievement been so rapid as during the last twenty years. During this time we have seen the development of the compound engine, of electric lighting and locomotion, of tunneling by compressed air, of modern ships of war, armament and guns, the completion of the Brooklyn and the Forth bridges, the perfection of railway travel, the substitution of steel for iron in construction, the erection of fourteen-story office-buildings, and many other triumphs of the powers of man over the resistances of nature, which will suggest themselves to every reader. On the theoretical side, also, there have been great advances. Numerous technical schools are yearly turning out graduates well instructed in the fundamental principles of mechanics and engineering, and of engineering books and periodical literature there is an overwhelming supply.

It has been said that Lord Bacon was versed in all the existing knowledge of his time, not so much on account of his vast brain power as on account of the fact that so little was then known which had the right to be called knowledge; but since his time knowledge has grown so fast that no one man has ever been able to comprehend more than a small fraction of it. So in that comparatively limited branch of knowledge known as engineering science, while Smeaton, Watt, Fairbairn, and others of the earlier engineers might have been expert in all the existing engineering science of their time, it has recently grown so vast that engineers have to classify themselves as civil, mechanical, electrical, sanitary and the like, and these branches are now so divided and differentiated that each engineer in practice must devote himself to a limited specialty if he wishes to achieve success in his profession.

In the acquirement of learning, one of the first and most important steps is to discover how vastly ignorant we are. In engineering the world is now taking that step. In the evolution of engineering practice from "the rule of thumb" and empirical methods of former years, into the more scientific and exact methods of the present, we are gradually finding out how lamentable is our deficiency in really exact and scientific knowledge, and how great is our ignorance not only of theoretical refinements, but of actual facts and data connected with our every-day experience. In quite recent years we were content with certain engineering rules and formulæ, if they were laid down by high authority, such as Weisbach, Rankine, Fairbairn, Hogkinson, or Bourne, and if a statement were found in the engineering pocket-books like Haswell's or Molesworth's, it was accepted without question. Now, however, we are beginning to doubt the accuracy of all the older authorities, and our confidence is extremely limited in the newer ones. These ideas were forcibly brought to our attention in hearing the recent discussions in the meeting of the American Boiler Manufacturers' Association. Simple questions, such as "What ratio of heating to grate surface should be adopted for different fuels?" "Is an iron chimney or a brick one the better?" "How high should a chimney be for different fuels?" and the like, were answered merely by opinions, which differed most remarkably, and not one of these opinions was based on any exact data or experiment. This is no reflection on the intelligence of the boiler makers present, but is simply an example of existing ignorance, which is not that of a few individuals, but of the whole world, and it is due to a lack of facts of record from which any opinion could be formed.

Concerning iron and steel, the metals most used by engineers, how little is really known. Why should cast-iron vary all the way from 12,000 to 45,000 pounds tensile strength per square inch, and what tensile strength can be predicted of any given mixture of irons in castings of different shapes? In wrought iron and steel constructions, how shall we determine the best factor of safety—which Holley truthfully called the "factor of ignorance"? Who knows whether high carbon or low carbon steel is best adapted to resist repeated strains without crystallization? Is there really any such thing as crystallization of iron or steel? If so, what proof is there of it? If not, why are such large factors of safety necessary? In the steam engine, is a steam jacket of any value, causing an economy of 20 per cent. of fuel, as has been claimed for many years, or of no value, as appeared to be the case in recent tests of the Pawtucket engine? What is the amount of cylinder condensation with different types of engine, and with different points of cut-off? What is the most economical ratio of expansion for different classes of engines? If large engines have developed a horse-power with 13 pounds of steam per hour, why is it necessary to use from two to four times that amount in small engines? In recent tests in England on the engines of four steam vessels, according to the *Engineer*, utterly contradictory and confusing results were obtained, so that we are yet in ignorance as to the conditions on which depend maximum economy of the marine engine. The Board of Trade in England has found the cause of breakage of the starboard engine of the "City of Paris," locating it in the wearing down of outside shaft bearing, near the screw. Why did not the similar bearing on the port side also wear down, or the two exactly similar bearings in the sister ship, the "City of New York"?

In the use of bituminous coal, who knows how to obtain the maximum economy from different qualities? Why should the Western coals, such as those of Ohio and Illinois, invariably give so much poorer results than Cumberland or Pittsburgh coal—results which are not accounted for by chemical analysis? Why, with all the march of invention, do the Western cities still suffer a cloud of smoke to rest over them as a pall?

We have stated that the engineering world is now waking up to discover the extent of its own ignorance. It is well, for the discovery of ignorance is the end of conceit, and conceit of knowledge is the great barrier to acquiring further knowledge. It is rapidly becoming no disgrace to an engineer to say, "I don't know," and to the engineering profession at large to say, "We don't know, but we are going to try to learn."

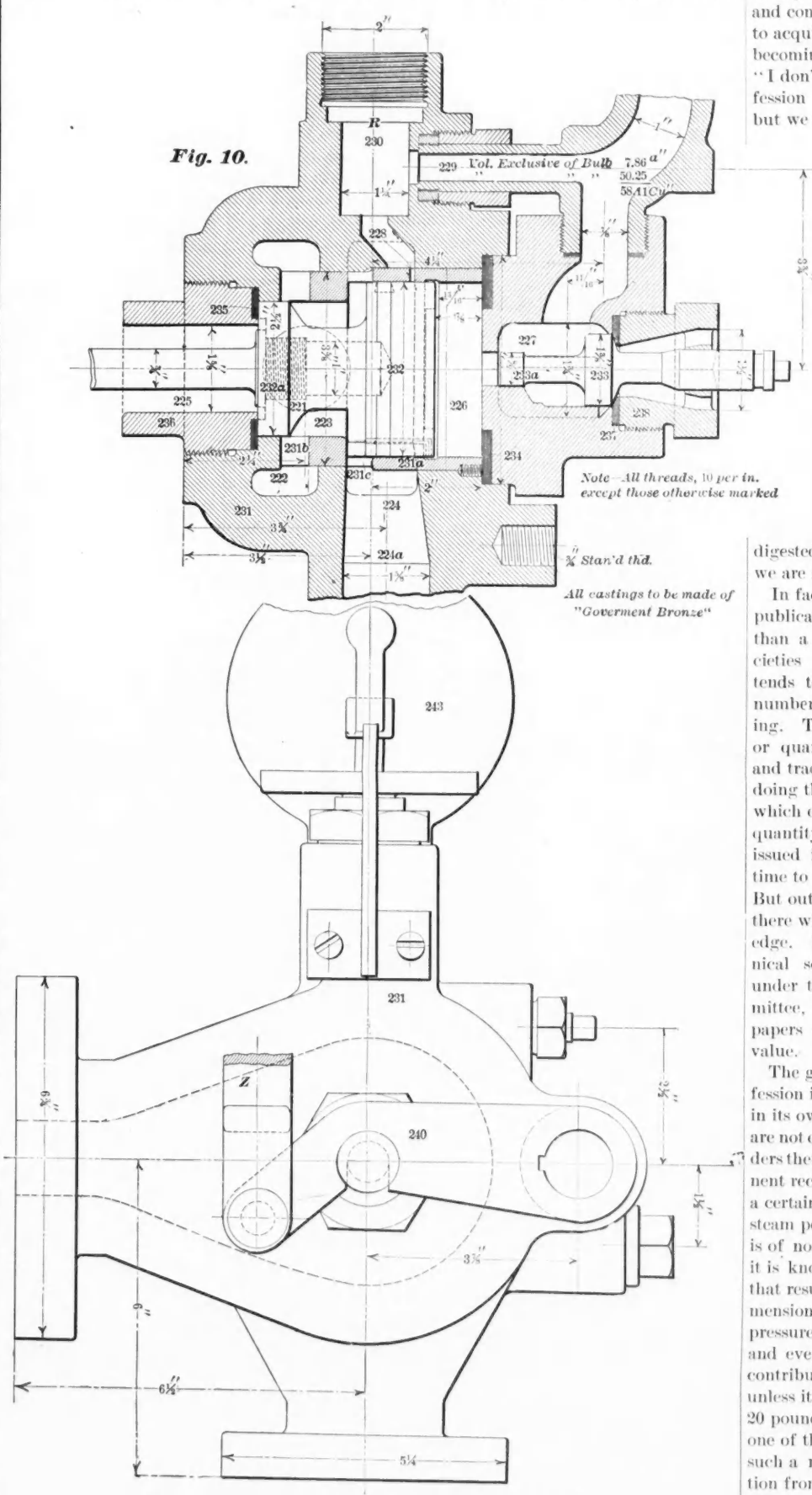
The next step is to take ways and means of removing our own ignorance, and of contributing to the advancement of the world's real knowledge. To do the first, careful observation and experiment, with the scientific method of thought, is essential. To do the second, prompt publication of carefully observed data is advisable, but there is already too much publication of crude observations, and hastily formed opinions based on incomplete data. It were better if the publication of opinions and generalizations could be deferred until at least a year after making the observations. This would greatly curtail the mass of badly digested engineering literature with which we are now inflicted.

In fact, the increasing bulk of engineering publications is becoming a burden rather than a benefit. Each of the technical societies publishes a yearly volume, which tends to grow larger every year, and the number of such societies is steadily increasing. The scientific colleges publish monthly or quarterly magazines, and the technical and trade journals, and the book-makers, are doing their share to swell the bulk of matter which engineers are expected to read. The quantity of such printed matter now being issued is so vast, that no engineer can find time to read more than a small fraction of it. But out of all this vast mass, how little is there which really is a contribution to knowledge. Even in the transactions of our technical societies, which are supposed to be under the censorship of a publication committee, and edited by a secretary, how few papers appear which have any permanent value.

The great reason why the engineering profession is still so ignorant of facts and data in its own science, is that these facts and data are not easily obtained in any shape which renders them valuable for comparison and permanent record. An isolated fact, such as that a certain steam engine requires 20 pounds of steam per hour to develop one horse-power, is of no value for scientific purposes, unless it is known precisely under what conditions that result was obtained, including type, dimensions, speed, cut-off, clearance, back-pressure, jacketing, quality of steam, etc., and even if these are all known, the result contributes but little to our knowledge, unless it can be determined how the result of 20 pounds will be varied by a change in each one of the numerous conditions. To obtain such a record, and to make any generalization from it, requires an exceedingly tedious and expensive investigation by a trained expert. A few years ago, an experimental compound engine, costing some thousand of pounds sterling, was presented to Owens College in Manchester, and experiments for nearly a year, undertaken by Prof. Osborne Reynolds, with an ample corps of assistants, have given thus far very few figures of permanent value in increasing our knowledge of compound engines, and the laws of their action. They, in fact, have thus far only served to reveal the fact how dense is our ignorance yet concerning these laws.

The immediate need of the profession in this matter is not more schools, more books, more society papers; but more experiment

Fig. 10.


Vol. Exclusive of Bulb 7.86 a"
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¾" Stan'd thd.
All castings to be made of "Goverment Bronze"

The Vesuvius and Her Armament.—See Page 4.

and observation. On account of the great expense involved in making accurate experiments, it is rarely that they can be made by individuals. The government is doing some work in this direction in its ordnance department, with the aid of the Watertown testing machine, the laboratories of some of the colleges, and some of the railroad companies are doing a little, but the latter make researches only on those matters that are of immediate practical importance financially in the business of railroading, while the colleges are generally hampered by lack of funds with which to carry on any important investigations. It is to be hoped that some capitalist who wishes to find a good way to make use of his money for the benefit of mankind, will, instead of founding a new college or library or art gallery, think of founding a laboratory of engineering research. Such a laboratory, well endowed, and in the hands of competent management, would be of vast service in solving many of the doubts which now trouble engineers, give us facts and figures from which we could design structures and machines with greater regard both to economy and to safety, and tend in a large degree to remedy a large part of our present engineering ignorance.

Deposited Copper Pipes.

The Elemore Patent Copper Depositing Company (Limited), of London, are taking orders for deposited copper pipes of any sizes up to 3 feet 4 inches in diameter and 10 feet long. The material of these pipes has a tensile strength of over 25 tons to the square inch, and an elongation of over 14 per cent. in four inches. After the experience of recent failures in copper steam pipes it is a relief to find that there is a pipe now made free from welds and joints of every kind, that offers absolute security with the high pressures now employed. Each pipe has etched upon it the results of a test which is made of a strip cut from its end. The pipe consists of pure copper, free from admixture with other metals, and the only variation which can occur is in its hardness. It is possible to produce hard or soft metal at will, according to the purpose for which it is to be employed.

The method of making these tubes consists in depositing the copper, by means of an electric current, upon a mandrel which is rotated in the solution. An agate burnisher travels along the mandrel, rubbing the particles of copper as they are formed into those beneath them, thus forming a fibrous plate of perfectly uniform structure and great strength. The speeds of mandrel and burnisher are so adjusted that only a very fine film can form between two applications of the burnisher to the same spot. The mandrel is covered with black lead, and after it is taken out of the bath the copper is rolled; this causes it to expand, when it can easily be slipped off.

Copper electrotypes are deposited with a current of six amperes per square foot. Each ampere deposits .00033075 grammes per second. Working day and night for six days = 144 hours, there will be deposited on a square foot 1,026 grammes, or $2\frac{1}{4}$ pounds of copper. This would give a plate $\frac{1}{20}$-inch thick.

The Elemore copper steam tubes are deposited at the rate of $\frac{1}{8}$ inch in thickness per week of 144 hours, or 6 pounds per square foot of surface.

It requires an electromotive force of from .2 to .3 volts to effect the chemical reduction of copper sulphate solution, and if we assume the combined efficiency of engine, dynamo, leads and bath to be only 25 per cent., then each indicated horse-power will deposit 888 grammes, or 1.95 pound of copper per hour. This shows a ton of coal used in a modern engine will deposit a ton of copper.—Condensed from London *Engineering*, July 11.

The Year's Railroading.

We are in receipt of the Introduction to Poor's Manual of the Railroads of the U. S. for 1890, which gives in condensed form much information that is of interest regarding railroads in this and foreign countries. Financially the roads are shown to be, upon the whole, in very good condition. For comparison of surplus earnings for 1889 with that of 1888, the roads of the country are divided into eight groups, the figures for which are given separately. In the New England, Central Northern and South Atlantic groups, surplus earnings are shown, where in 1888 there were deficiencies. Most of the other groups do not make so good a showing, though the total for all the roads of the country show over twice as great surplus earnings as in 1888; the figures for '89, being $30,526,520, while for '88 they are $14,708,010. Compared with 1888, the gross earnings for all the roads increased $43,480,326, and of this amount the elevated roads alone contributed $1,245,478. Passenger earnings upon other roads show an increase of $8,284,640, and freight earnings an increase of $27,329,830, the balance of the increase being made up by earnings on mail express, etc. The most marked increases in earnings are shown in the States west of the Mississippi and east of the Rocky Mountains. In the Middle States the losses in gross earnings suffered by the coal-carrying roads kept the increase for the section down to a narrow margin of $4,500,000, while the whole South fails to show any gain of consequence. In the latter case this failure to show expected results is due almost wholly to the inability of the vast number of new roads which have been brought into operation to report for a full year, as the date of their several openings in nearly every case antedated the close of their fiscal year only by a few months. In consequence, the figures of actual traffic statistics cover only the part of the year during which the several roads were operated in 1889. The total number of miles of railroads in the U. S. at the close of '89 was 161,397, of which 5,751 were constructed during the year. The cost per mile of all roads making returns, as estimated by the amount of their stocks and indebtedness, is $60,309, against $60,732 for 1888, and it is stated that there is every evidence that the railroad system of the country could, under reasonable conditions, be operated for 60 per cent. of its gross earnings. The book is accompanied by one of the maps of the *Engineering News*, showing railroad construction for the years 1886, '87, '88 and '89.

H. & V. W. H. Poor, 78 Wall street, New York.

LETTERS FROM PRACTICAL MEN.

Preparing and Making Corrections on Tracing Cloth—Lettering Drawings.

Editor American Machinist:

For most draftsmen to make a correction on tracing cloth means a blot, in other words to spoil a perfect drawing; yet it can be easily and artistically accomplished in the following manner. On the drawing which it is desired to correct, make pencil corrections, using a soft lead, so that the lines will be black; this should be done without erasing the inked error, for in this point lies the secret of success. After pencil corrections have been made, turn the sheet over and ink them in; when the ink is perfectly dry, turn sheet face up again, and erase inked error. The correction will never show on a print. I find a sharp knife eraser the best to use.

Though directions for preparing tracing cloth may seem superfluous, from what I have seen it is evident that everybody does not know how it is done. To begin with, the proper side of the cloth to draw on is the rough or unglazed side. To prepare it so that it will take ink evenly, proceed as follows: From a druggist secure some powered terra alba, rub this on the cloth with a piece of chamois skin, or soft flannel, dust sheet off and it is ready for use. Powdered chalk will answer the same purpose, but is not as convenient.

To the writer, nothing looks more vulger than fancy letters and figures on mechanical drawings. At first thought one might think that plain letters and figures are easier to make, but to design each letter, and have its proportions such that it will be attractive, is very difficult, besides requiring much more time than most draftsmen can spare.

For all of my drawings I use plain Gothic letters, and the effect produced is surprising and very attractive to the eye, all letters except the S's, and the backs of B's, and R's, being drawn mechanically, and a perfect copy of printers' type. Their formation is secured as follows: In a blank book about twelve inches square I have pasted the different styles and sizes of type that suit my fancy, giving each size and style a separate place. The styles can be secured as follows: Get six or eight different issues of half a dozen different papers that represent your trade, or work kindred to it; from these clip the sizes and styles desired, assort and paste in book. From the different issues will generally be found all the letters of the alphabet. When the letter book is complete, and it is desired to letter a drawing, proceed as follows: Take a strip of tracing paper, mark on it at each end the height of the letters that it is desired to copy, then connect points with a top and bottom line (this is done to make line straight); between these boundary lines, trace (free hand) the words desired. If the papers from which the styles were cut represent your trade, many of the words that you will want will be found complete. After words are traced, put paper under your drawing, and copy in ink, drawing the horizontal lines first, then the vertical; fill in with brush or pen, according to size of letters. This process requires much less time than that ordinarily expended on this part of the drawing, besides giving very handsome results. If it is desired to line the letters on a paper drawing, or where it cannot be traced, prepare the tracing paper, and rub colored lead on the back of it, put tracing paper in position that it is desired to have letters, then with a hard lead pencil, go over outlines of the letter; the impression will be left on the paper.

J. L. B., Jr.

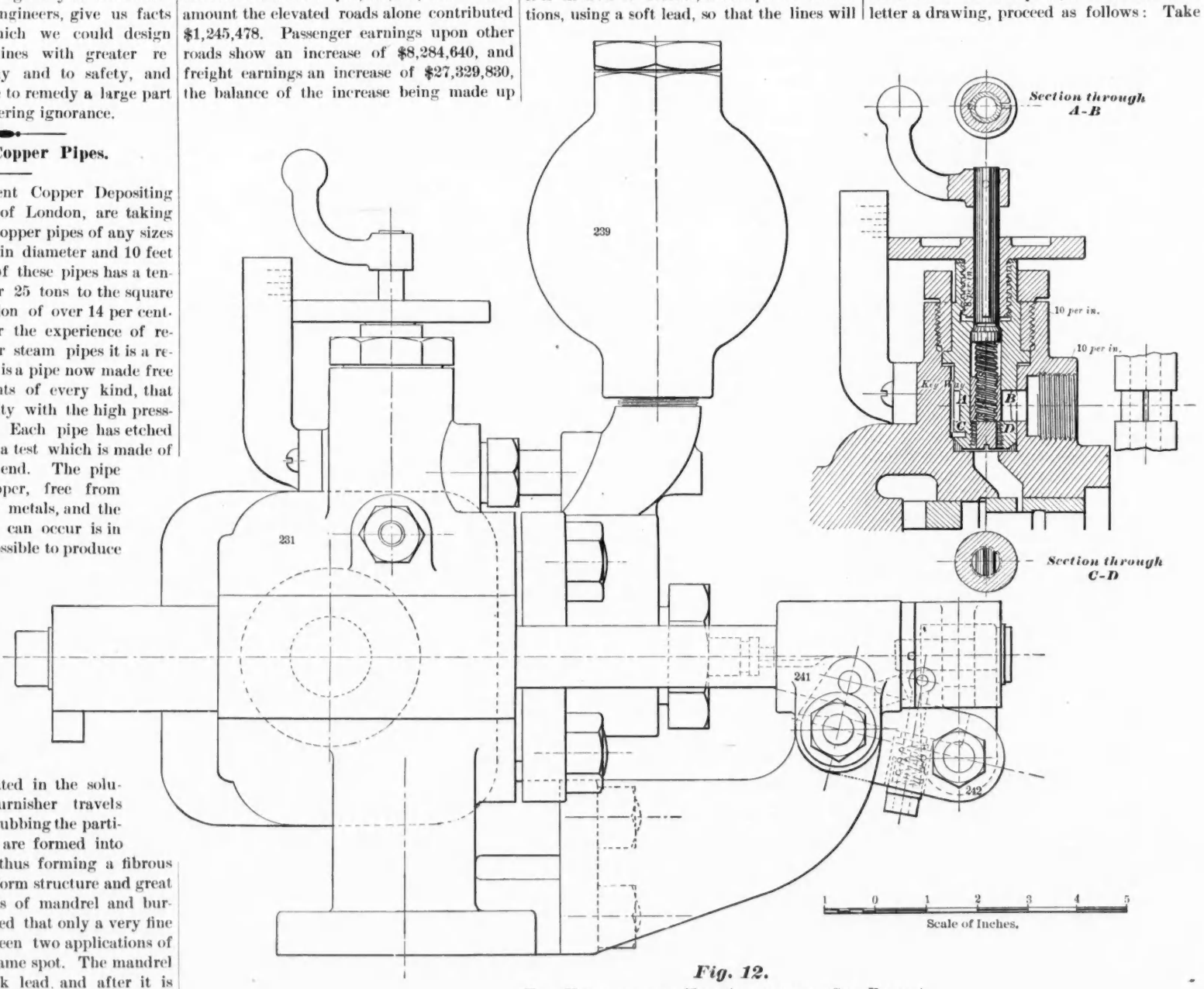

Fig. 12.

THE VESUVIUS AND HER ARMAMENT.—SEE PAGE 4.

Fixtures Fit any Machine.

Editor American Machinist:

The article of Grant Sipp, in your issue of July 17th, page 7, on making fixtures fit in new machines, treats of an excellent device, but one rather older than his article might lead us to think, for I have used this device for from fifteen to eighteen years, although, when it is possible to have my orders for machinery filled, I always specify that the grooves in the machine be left blank, and under a certain size, so that I may plane them to uniformity, but when unable to do that have resorted to the "tongue blocks," as described in the article to which I have alluded.

A. Webster.

The Term Calorimeter.

Editor American Machinist:

Referring to your paragraph in July 17 number of the American Machinist, in which you ascribe the original use of the word calorimeter—as expressing the sectional area of boiler flues—to Mr. Isherwood, you are quite mistaken.

I have by me some old boiler drawings made back in the fifties, in which the word occurs having that meaning. Again, in Bourne's Treatise on the Steam Engine, 1860 edition, occurs this language: "The sectional area of the flue in square inches is *what is termed* the *calorimeter* of the boiler," so that the use of the word in that connection is English, and of long standing.

It probably had its origin, when hot air or gas was called caloric; thus Ericsson's hot-air engine was called a "Caloric Engine," the mystery connected with which enabled him to raise large sums of money from the credulous people of New York.

William H. Harrison.

Braintree, Mass.

Proportioning Wearing Surfaces.

Editor American Machinist:

Mr. Wilfred Lewis' able treatment of the question of the proportions of wearing surfaces gives a width of the V to equal a flat, that is new to me, as I have no doubt it will be to many. In this connection, as a matter of interest, I wish to call attention to an unsatisfactory result that must have been noticed by all careful observers, and to suggest a remedy.

In Fig. 1 is shown the lower point of a planer V, made in the usual way, and the same as shown by Mr. Lewis.

Fig. 2 shows about how this point will appear when excessively worn, which, when it becomes necessary to refit, is objectionable.

Fig. 3 shows a form that, assuming the material to be the same in each piece, will pretty effectually remedy it, I believe, no matter what the diverging angles may be, so that the vertical distances (*a* and *b*) be equal.

In regard to cutting the surfaces away, as

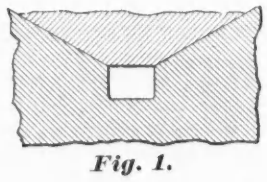

Fig. 1.

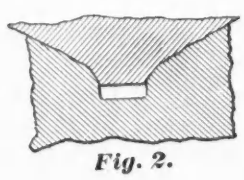

Fig. 2.

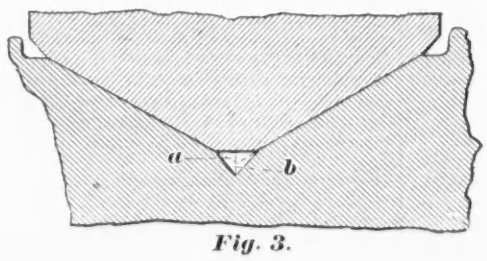

Fig. 3.

shown by Mr. Armstrong, it neither looks as badly nor is it as troublesome to keep clean as we had anticipated. The relief being not to exceed $\frac{1}{64}$ of an inch, with rounded corners left with a file, it is not at all bad to wipe. Doing a thing, and believing a thing to be right, I know helps wonderfully to modify a fellow's ideas of looks, but from the fact that outsiders do not point to the surfaces as a mutilation, we are led to conclude that it is not so bad as might be supposed. I had thought it might be 20 years before any one else would repeat the experiment, but if such a firm as the one Mr. Lewis is connected with should try it, become convinced, as I believe they would, both as to its correctness, and that really it is endurable, the practice would be followed. When the wearing surfaces are to be scraped to a perfect bearing the cost is not enough more to be taken into account.

John E. Sweet.

The Mills' Mysterious Dullings—Cause.

By Jarno.

The mills had dulled a great deal more than usual. They had dulled so much that they could not be sharpened without too much loss of size. They had to be thrown away. Though often sought for, yet the cause had remained a mystery.

There were several sizes of these mills, averaging one and a quarter inches diameter and three thirty-seconds thick. They were used in an upright spindle of a profiling machine, for cutting slots in the edges of pieces made up of two parts, as at *A B*, Fig. 1, the mills being dropped in. A new man was running the machine, which was the only known difference in conditions since the time when the mills held their edge.

At the time when my story opens, the new man, holding in his hand a dulled mill, had just come to the foreman for another. The case was getting serious. Six slots were to be cut, and this mill was spoiled before cutting one. The foreman resolved to take hold of the machine himself, and, if possible, add something to the store of things that were known in his shop.

It was a curious fact that the mills dulled more at the lower side *D*. This might be

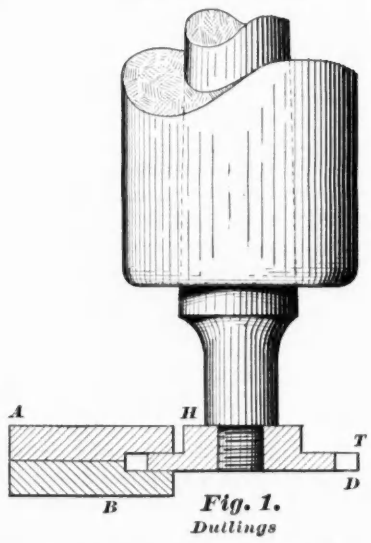

Fig. 1.
Dullings

expected if the lower part *B* of the piece to be slotted were harder than the upper part *A*, but no difference could be discovered, and both were quite soft. The mills appeared to be hard enough. There seemed to be no other thing to do but for the foreman to attempt to cut some slots himself.

Now when foremen, by practical illustration, attempt to show workmen how to do a thing, they sometimes fail. Being mad with a workman for making a slump, Waubug, Jr., attempted to show how to make a good fit. He made another and a worse slump. But our foreman, though young, is not more eager than vigorous; when he feels sure of a thing he is also cautious; he often hastens, but never hurries.

He put in a new mill, and finished the slot in which the first one dulled; this, as every machinist knows, is risky, because an unfinished slot, cut by a dull mill, is not only liable, but likely to be glazed, and hard for the next mill to cut. Five slots more were cut, and the new mill was not dull.

He discovered the cause of the trouble. It was remarkable as showing that ways to do a thing wrong can be found out which would baffle ingenuity to surmise. To keep the mill cool, soda water was used. The workman had led it to the hub *H*, which, by rapid rotation, threw it off, barely wetting the upper corners of the teeth at *T*, in its passage. Though the upper part of the mill was covered over with water, yet it hardly touched the mill except at the hub, which explains the dullings, and why there was more at the under side. The water is now led directly to the teeth, and, in consequence, they hold their edge. The mystery is solved.

An Insulator for Steam Pipes.

Where steam or hot-water pipes pass through woodwork in buildings it is of course desirable to protect the woodwork

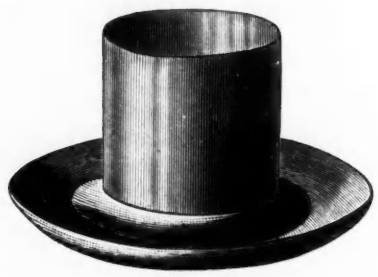

Fig. 1.

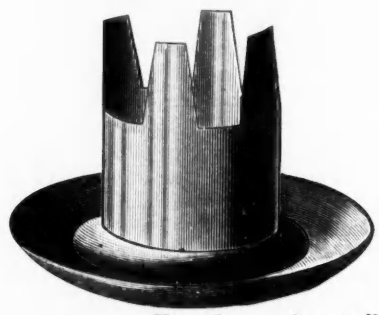

Fig. 2.

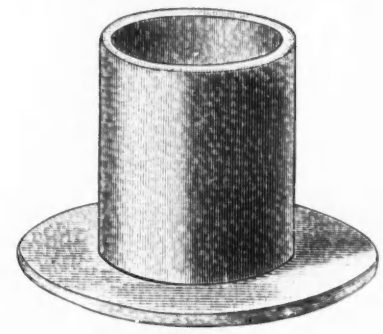

Fig. 3.

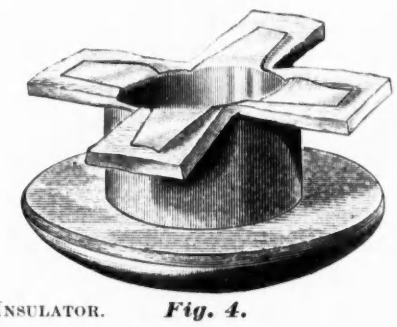

Fig. 4.

Steam Pipe Insulator.

from the heat, both on account of the danger from fire, and also because the paint or varnish which may be on the wood is otherwise disfigured. Figs. 1 and 2 of the accompanying engravings show the ordinary form of floor and ceiling plates, while Figs. 3 and 4 show the improvement made upon them by the Perfection Insulator Mfg. Co., of 134 North Christian street, Lancaster, Pa.

As will be seen it consists simply of a covering for the plate, which is made of a non-conducting substance composed mainly of asbestos. This prevents any part of the pipe and woodwork coming into contact, and effectually prevents injurious heat reaching the latter. The method of its application and appearance when applied will readily be understood from the engravings. They are regularly made for all sizes of pipe up to and including 3", and can be made to order at short notice for sizes above 3".

A press dispatch from Pittsburgh says:

The immense volume of iron and steel manufactured in the Pittsburgh district the first six months of this year differs but little from the corresponding period in 1889. The reason is that mills have not materially increased their capacity. Carnegie Brothers & Co., Jones & Laughlin, and the Oliver Iron and Steel Company, daily finished about 3,200 tons, nearly one-half of the output of the district, which is fully 7,000 tons. For 140 days in these six months, at 6,800 tons a day, the total production was 952,000 tons. Of this amount about 280,000 tons were steel rails. The firm of Carnegie made alone well-nigh 325,000 tons. That includes the output of their plant at Beaver Falls, but from their four plants in Pittsburgh, it was just about 300,000 tons, being a little more than 2,000 tons a day, or altogether one-third of all that was made. And outside of their steel rail output they manufactured in this year about 12,000 tons of railway car supplies, and nearly 140,000 tons of structural material.

The production of pig-iron in the first ninety days of this year was about 3,400 tons a day, making 306,000 tons; and in the last quarter it went to 3,600 tons, which made it 324,000 tons, being a total of 630,000 tons. The average output from the Carnegie furnaces was 1,800 tons a day.

Comparing the entire output of pig metal with the amount of finished iron and steel turned out, it is shown that Pittsburgh manufacturers had to go into outside metal markets to buy, in six months, at least 300,000 tons of pig-iron.

They Ought to be Inspected.

Another explosion, in New York, of a generator used in the manufacture of carbonated beverages—an explosion attended with loss of life—will possibly call attention to the policy of a rigid inspection of such apparatus, and a license of those having it in charge. There is no reasoning that applies to the inspection of steam boilers that does not apply with equal or greater force to these generators. They are likely to be seriously weakened by the action of the acid used, and by the process employed a high pressure may be reached. Moreover, they are usually placed in the hands of men who know little or nothing of the strength of materials, or the effect of internal pressure. It seems no more than reasonable that they should be placed under strict surveillance by those who do know something of such things.

Mayor Hart, of Boston, perhaps with occurrences in New York in his vision, advises the City Council to provide for stringent supervision of electric wires and appliances. He advises the creation of a department for that purpose, the superintendent of which shall have supervision of all electric wires; also of dynamos and electrical machines. Application for the erection of all wires and electrical machinery must pass this superintendent. The Mayor reasons that a dynamo is as much a thing of danger as steam engines and boilers, which no one can erect in the city without a permit, and that the wires carry the danger all over the city; therefore, "the city should meet this great and growing danger without further delay." The Mayor's advice, undoubtedly, ought to prevail, but the superintendent in whom so much power is to be vested, should be a man of great ability, and undoubted integrity. The object in all such instances should be to assist, not hinder, the use of electricity. But, first of all, of course, the people should be protected.

Over two years ago we called attention to the fact that New York city was fast becoming a soft-coal city, and that it seemed not unlikely that it would in time become clouded by a black pall, the same as some of the Western cities where soft coal is practically the only fuel. This fact is now beginning to attract the attention of others, and is being commented upon in the daily press; coal dealers saying they notice the difference in their trade, and other merchants declaring that they also notice the difference in the amount of goods injured by the deposit of soot upon them from neighboring chimneys.

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☞ We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.

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NEW YORK, AUGUST 7, 1890.

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Stop the Leaks.

With the results of leaks about boilers and engines so well known, it is certainly strange that so many of them are to be found. About a boiler a leak begins immediately to waste away the material, the rapidity with which this wasting process goes on appearing to be controlled to some extent by the quality of the water used; it goes on, however, whatever the quality of the water. Sheets are thinned down, and rivets are nearly destroyed, till often the danger of an explosion becomes imminent.

It is not always at the place of the leak that the greatest damage is done. The water from the leak may find its way to some part of the boiler resting upon a support, or to some part against which the brickwork rests, and although the leak may be small, the shell may be rapidly wasted away.

Not long since, we saw a boiler that was solidly covered with asbestos. A small drip appeared at the bottom of the boiler, and, owing to the inconvenience of coming at it, and the desire to keep steam on all the time, the leakage was permitted to go on. Finally the boiler was blown off, and a search made for the leak, which was several inches from where the drip appeared. It was found that for a spot about twice as large as the hand, the shell—of iron—was eaten away to one-half its original thickness.

It is proper to say that the asbestos had nothing to do with the corrosion; it would have been the same with any other covering. The trouble was not with the covering at all, but in the fact that the insignificant leak had been permitted to get in its work for two months or more.

Flanges riveted to boilers sometimes get leaking slightly, and, especially if on the under side, a slight leak may go on for some time unnoticed, unless such places are systematically examined. The result is frequently a serious weakening of the shell under and around the flange. There is no time so good for stopping a leak about a boiler as when it first appears. It is both cheaper and safer to stop it then.

Leaks through the stuffing-boxes of steam engines score the rods, and in time make it impossible to keep them packed tight except they are put under enormous friction. It is only fair to say, in this connection, that some steam engine builders make so little allowance for stuffing-boxes that it is well on towards impossible to keep them packed against leakage. But every effort should be made to find some way of so packing them.

Leaks around joints—cylinder heads and chest bonnets, and the like—soon eat away the metal, bringing about a condition difficult to contend with. The moral is: Stop all leaks around boilers and engines, not alone, or principally, perhaps, for the steam wasted, but for the damage such leaks will do.

Regarding Boilers.

The *Safety Valve*, a journal published in this city, and which is popularly supposed to have an umbilical or other connection with a boiler inspection and insurance company, seems to have discovered a mare's nest in our editorial article entitled "Regarding Boilers," in issue of July 17. And having discovered this mare's nest it proceeds to do as all other discoverers of mare's nests invariably do, *i. e.*, to make a great fuss over it.

In the editorial referred to we attempted to point out some of the difficulties which boiler manufacturers, who aimed to do nothing but good work and get a fair price for it, had to contend with, owing chiefly to the ruinous competition of boiler manufacturers, who were determined on nothing except to make present gains without much regard to means. Our worthy—but we fear slightly hysterical—contemporary takes part of this editorial, and uses it in a circular, which it is at present engaged in distributing among boiler manufacturers, evidently expecting them to also go into hysterics over it, and to answer certain questions—so framed as to make it appear that we have made charges against every establishment that makes boilers—by thunderous negatives; and it promises to publish the answers. In this circular every qualifying or modifying statement made in our editorial is carefully excluded.

Now, of course, our worthy contemporary does not at this moment dream that we know anything about this circular, but some of these boiler manufacturers have taken the trouble to send us the circular, and to state at the same time that they fully indorse all that we have said about the matter. Which only goes to prove what we knew to be the case all the time, *viz.*, that we were simply voicing the almost universal sentiment of the best and most conscientious boiler manufacturers of the country; and as for the sentiments of the worst and least conscientious we care nothing. The condition of affairs which we plainly stated and deplored in that editorial is generally recognized by boiler manufacturers themselves, and one of the chief objects in the formation of the Boiler Manufacturers' Association was to improve that condition. We therefore predict that the answers to the circular by boiler manufacturers who have read our editorial complete, and who are endeavoring against heavy odds to conduct their business as it should be conducted, will not be to our contemporary's liking. The fact that the condition of affairs set forth by us is recognized by the best boiler makers is the most encouraging feature of the situation, for in that fact lies the only hope of improvement. Our contemporary has discovered a mare's nest; nothing more and nothing less.

The Annual Slaughter.

We are again reminded that the threshing season has opened in the West, by the reports of explosions of boilers in the wheat fields of that section. An Indiana paper contains an account of what seems to have been a peculiarly violent and destructive accident (!) of this kind, by which four men were killed and a fifth injured. Several horses were killed, and the wreck of the engine and its surroundings is described as complete. Of course it is an old story, and one which, with slight variations as to details, has to be told over again many times every year during the season, which extends from the middle of July to the 1st of October. There is little use in recounting for the instruction of our readers the causes which lead to such disasters; they are familiar, but perhaps it is our duty to again call their attention to the fact that a good work can be done by educating the public to know that unless a boiler is properly constructed of proper materials, and then properly cared for by competent persons, it is a highly dangerous thing; and that the vast majority of the boiler explosions that occur are entirely preventable, and that of those which occur with threshing engines a much larger proportion are preventable than with any other class of boilers, with the possible exception of saw-mill boilers. The entire steam plant of saw-mills is usually neglected, for the simple reason that fuel costs nothing. In most cases the same is true of threshing machine engines, which consume straw or wood furnished by the farmer for whom the threshing is done, and the same neglect, brought about by indifference as to the quantity of fuel burned, also brings about the conditions favorable to an explosion. The men who have charge of these engines are not to be reached by technical journals, for, of course, they never see them; but their knowledge of engine running is too often derived originally from the agent who sells the outfit, and who himself usually knows just nothing at all about it. Legislation to secure inspection, and requiring licenses, might do some good, but as such legislation must be enacted by the several State legislatures, there is much work in the educational line to be done before good laws can be passed and enforced. If we had in this country a body similar to the Board of Trade in England, much might be accomplished by it, and the mere publication in the various country papers throughout the region of country where threshing is done, of a concise set of rules and directions to be followed, and cautions to be observed in the care of such engines, coming from some such authentic source, might possibly be of benefit in the same way as directions and suggestions from various boards of health now are.

But, of course, the fault is not entirely with the care that such engines receive. The competition in prices is very keen on such machinery, and the expense of selling it after it is built is very heavy, with the result that much material and work go into such boilers that should not be allowed, thus making it harder for those manufacturers who are too conscientious to turn out any but good work to keep in business. Nothing, perhaps, but rigid inspection laws will do any good with this part of the evil.

We presume that every man, woman and child in the United States, knows by this time that the man who invented the return ball made a fortune out of it. And we presume further, that every man, woman and child is thoroughly sick and tired of being told about it in the newspapers. Every time this hoary chestnut is revived, every paper—especially those interested in patents—must needs rehearse it over again. Now, we say we are glad the man made a fortune, and hope he is enjoying it at the present moment; but, if we are always and forever to be told about it, we shall wish he had never been born, or that the first returning ball had slain him.

It is reported that the Chicago Gas Company has voluntarily offered to reduce the price of gas to consumers to one dollar per thousand feet. The only explanation we can give of this phenomenon is that a new and much more efficient gas meter has been devised. The size of gas bills depends much more upon the efficiency of the gas meter than upon the price of gas per thousand feet.

In the June number of *Mechanics* it is announced that Mr. Henry H. Supplee's connection with that journal as editor will cease, he taking a position with the Yale & Towne Mfg. Co., at Stamford, Conn. Mr. Supplee's many friends will, of course, join us in the hope that success will attend him. He is one of those who deserve success.

Chief Bonner, of the New York Fire Department, says that good brick is the best fireproof material in the world. It appears that the brick of the Western Union building stood up squarely against the fire, while the stone crumbled and flaked badly.

It is announced by Secretary Hutton that the 22d convention (also the eleventh annual meeting) of the American Society of Mechanical Engineers will be held at Richmond, Va., and will probably begin Nov. 11.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(303) H. T. H., ——, Mass., asks: Can you inform me how sheet-metal caps for fruit jars are threaded? *A.*—The threads are rolled in by special machinery.

(304) C. A. T., ——, writes: A. says that in a gas engine the pressure is not elastic, and that pressure is only exerted at the instant of explosion. B. says that the pressure follows the piston for at least a portion of the stroke. Which is right? *A.*—B. is right. Power cannot be obtained from pressure alone; there must be motion while the pressure is applied. The gases generated by the explosion in the cylinder of a gas engine expand as the piston moves through the cylinder, and exert pressure during nearly or quite all the stroke.

(305) H. S. R., ——, asks: Will you please give me some advice about learning to be a locomotive engineer, which is my intention. What is the first step, or what studies should I be interested in? I am about fourteen years of age. *A.*—The studies which you should be interested in will depend much upon your present acquirements, but you should have a good knowledge of arithmetic and of physics especially. Then, when you become older, apply for a place as fireman. You may become a good engineer without knowledge of the studies named, but it is far better to acquire them, especially if you should ever aspire to a position above the footboard.

(306) W. C. G., Columbus, Ohio, writes: Please inform me where to apply for an engineer's license, and also whether the examination will be very hard. I have learnt the machinists' trade, but have not worked in a shop for some time past. I would like to manage a steam plant without a license. *A.*—If you mean to take charge of a steam plant in the city of New York you will have to apply for a license at the office of inspection of steam boilers, 300 Mulberry street, New York City. You will not be allowed to have charge of boilers without a license. See answer to Question 267, in our issue of July 3, current volume. We believe the examinations to be comparatively easy; whether they will appear to be so to you will depend on your ability.

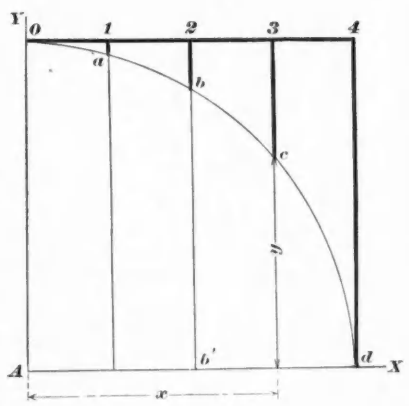
(307) C. H., San Francisco, Cal., writes: I am an apprentice working at pattern making, and I would like to learn to read drawings. What book would you recommend? *A.*—We believe that the papers on Practical Drawing, which have been recently concluded in our columns, will teach you to read drawings. 2. Do mechanical draftsmen have steady work? *A.*—Some of them have; they have to take their chances like all other mechanics. 3. How long does it take to become a thorough draftsman? *A.*—It is impossible to give any stated time in which a person should become a thorough draftsman, as that will depend on his ability and energy. Under the most favorable conditions it will take several years, and some men will not become thorough draftsmen in a lifetime.

(308) J. F. S., Silver Springs, Fla., asks: What is the heating surface of a Scotch boiler 54 inches diameter, 72 inches long; furnace, 26 inches diameter; 82 tubes, 2 inches diameter? *A.*—You have not given sufficient data for us to compute the heating surface accurately, but we should estimate it at 260 square feet. 2. Will the boiler drive two engines, 7x20 inches, to turn one 10-foot paddle-wheel 36 times per minute? What is the horse-power of the engine and boiler? *A.*—Assuming the boiler pressure to be 100 pounds per square inch, the boiler will be large enough to drive the two engines. The horse-power of the two engines, under the foregoing conditions, we should estimate at 14 I. H. P.; and the horse-power of the boiler, allowing 15 square feet of heating surface per horse-power, we should estimate at about 17 horse-power. We cannot say whether the engines are large enough for the wheel, as you have not given sufficient data.

(309) G. M. F., Winona, Me., writes: I have a boiler 48 inches diameter with two 16-inch flues, seams single-riveted lap joints. The largest hole, excepting the manhole, in any part of the boiler is 2½ inches diameter, which is used for the steam pipe. The boiler is quite old. There are no leaks of any kind, and the metal seems to be as tough as any I have ever worked. What pressure do you think is safe for this boiler to carry? *A.*—You have not given us the thickness of the sheets, and, even if you had, we would not attempt to state the safe steam pressure which the boiler can carry. Old boilers should be thoroughly examined before they are used, and the steam pressure fixed to suit the conditions of the boiler. Our advice is, not to use the boiler until a competent person has examined it. 2. What kind of safety valves do you consider the best? *A.*—We should use a pop safety valve; of these, there are several kinds on the market.

(310) A. S., Warren, Mass., writes: I intend to build a boat 16 feet long, 4 feet beam, 2 feet deep, of steel $\frac{3}{16}$ of an inch thick. Do you think the steel is thick enough? *A.*—We prefer to use steel $\frac{1}{16}$ of an inch thick. 2. Do you think the boat can be built without any special machinery? *A.*—You will not need any special machines, but you will need suitable formers and hand tools, and, above all, an experience in building boats. 3. Would you use lap-riveted joints, or would you butt the ends of the sheets? *A.*—We should use lap-riveted joints for the longitudinal seams, and run the plates the whole length of boat. 4. I want to use a 2½x3 inch engine; is it large enough for the boat? *A.*—Yes. 4. What should be the size of the boiler? *A.*—We should advise you to use a safety water tube boiler, of which there are several in the market. Nearly all boilers of this class are patented, and therefore you cannot make one yourself. Write to any of the makers of these boilers, and they will furnish you one of the suitable size.

(311) W. H. T., Ludington, Mich., writes: Please give me a rule for finding the rate of increase between the circumference of a circle and a line tangent to it. For instance, let the radius of the circle in the accompanying figure be four inches, what will be the length of the lines 1*a*, 2*b* and 3*c* drawn perpendicular to the tangent, and terminating in the circumference? *A.*—First find the lengths of the lines drawn from the diameter parallel to the tangent to the circumference. Thus, let *A* be the center of the circle, and *A d* a diameter drawn parallel to the tangent 0 4; *c*, a point on the circumference; *x*, the horizontal distance from *c* to the axis *A Y*; this axis is drawn perpendicular to the axis *A X* through the center *A*; it is required to find the distance *y*. For finding *y* we have the equation $y=\sqrt{r^2-x^2}$, in which *r* is the radius, and is, in this example, equal to four inches. Let *x* be 3 inches. Now substituting for the symbols their values we have $y=\sqrt{4^2-3^2}$; performing the operation as indicated, we have $y=\sqrt{16-9}=\sqrt{7}=2.64$ inches. The same equation will also determine the distance from any other point on the circumference to the axis *A X*; but in applying this equation we must remember that *x* and *y* are the co-ordinates of the given point. Thus, for instance, let it be required to find the distance from the point *b* to the axis *A X*; now in applying the equation we



must remember that *x* is equal to the distance *A b'*, and *y* is equal to the distance *b b'*; if *A b'* is two inches, then

$$y=\sqrt{r^2-x^2}=\sqrt{4^2-2^2}=\sqrt{12}=3.46 \text{ inches.}$$

Hence if
$x=0$ then $y=4$,
$x=1$ then $y=3.87$,
$x=2$ then $y=3.46$,
$x=3$ then $y=2.64$,
$x=4$ then $y=0$.

After the values of *y* have been determined we can easily find the lengths of 1*a*, 2*b*, 3*c*, by simply subtracting the corresponding values of *y* from the radius; in this example we have,

$1\,a=4-3.87=0.13$,
$2\,b=4-3.46=0.54$,
$3\,c=4-2.64=1.36$.

(312) J. S., Newark, N. J., writes: I am anxious to know the rule for determining the area of a safety valve for any kind of boiler. For instance, what should be the area of a safety valve for a boiler 48 inches diameter, 20 feet in length, sixty tubes 3 inches diameter, and 21.75 square feet of grate surface? *A.*—There are many rules for finding the area of a safety valve, but the grate surface seems to be, all things considered, the best unit of measurement for determining the size of safety valves. The rules given by the Board of Supervising Inspectors of Steam Vessels are easily remembered, and the safety valves proportioned by these rules will be ample in size for any requirements. These rules are as follows: Lever safety valves to be attached to marine boilers shall have an area of not less than one square inch to two square feet of grate surface in the boiler, and the seats of all such safety valves shall have an angle of inclination of 45 degrees to the center line of their axis. The valves shall be so arranged that each boiler shall have one separate safety valve, unless the arrangement is such as to preclude the possibility of shutting off the communication of any boiler with the safety valve or valves employed. This arrangement shall also apply to lock-up safety valves when they are employed. Any spring-loaded safety valves constructed so as to give an increased lift by the operation of steam, after being raised from their seats, or any spring-loaded safety valve constructed in any other manner, or so as to give an effective area equal to that of the aforementioned spring-loaded safety valve, may be used in lieu of the common lever-weighted valve on all boilers, on steam-vessels, and all such spring-loaded safety valves shall be required to have an area of not less than one square inch to three square feet of grate surface of the boiler, and each spring-loaded valve shall be supplied with a lever that will raise the valve from its seat a distance of not less than that equal to one-eighth the diameter of the valve opening, and the seats of all such safety valves shall have an angle of inclination to the center line of their axis of 45 degrees. But in no case shall any spring-loaded safety valve be used in lieu of the lever-weighted safety valve, without first having been approved by the Board of Supervising Inspectors. According to these rules, the area of the opening of a lever safety valve for a boiler having a grate surface of 21.75 square feet should be $\frac{21.75}{2}=10.87$ square inches; the corresponding diameter is nearly 3¾ inches. For a spring-loaded safety valve the area of the opening should be $\frac{21.75}{3}=7.25$ square ins.; the corresponding diameter is nearly $3\frac{1}{16}$ inches.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Universal Vise Chucks. Pedrick & Ayer, Philadelphia, Pa.

Link Planer Attachments. Pedrick & Ayer, Philadelphia, Pa.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

F. C. & A. E. Rowland, New Haven, Conn. Hydraulic, Mill and Special Machinery to order.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

Wanted—Screw machine work of any description; lowest prices work guaranteed. Blauvelt & Haldy, Pearl and Front sts., Brooklyn, N. Y.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Patent Attorney, R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

25" Upright Drills a specialty. Finely made,
28" great capacity, quickly operated, prices low.
32" Send for list of firms using our Drills. J. E.
36" Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting
Rods for small connections.
Especially adapted for Valve
Rod for Steam Engines.
T. C. Dill Machine Co.,
Philadelphia, Pa.

Screw Propellers.
Manufactured by H. B. Roelker,
22 Cortlandt st., New York,
Superintendent of the late De Lamater Iron Works, of same patterns and designs as before, adapted to each vessel. Consulting Expert and Constructing Engineer. Estimates on machinery, damages, etc. Air ice machines.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES

Pensacola, Fla., will have a $100,000 fertilizer factory.

It is stated that an ice factory will be erected at Hot Springs, Ark.

The Gage Lyons Ice Co., of Mobile, Ala., will add a 25-ton ice machine.

W. P. Martin, Jr., will erect a saw and planing-mill at Kilgore, Texas.

The Atlanta (Ga.) Glass Company will issue $50,000 bonds to enlarge works.

C. M. Johnson's sash and door factory at Tacoma, Wash., was recently burned.

The carriage factory of E. D. Meadimber, Omaha, Neb., was recently destroyed by fire.

The sum of $10,000 has been subscribed to establish a shoe factory at Greensboro, N. C.

The Blacksburg (S. C.) Machine and Iron Works will erect plant. Capital stock, $10,000.

The Crescent City Ice Company will add a 35-ton ice machine to its plant at New Orleans, La.

The Avondale Ice Factory, of Birmingham, Ala., will add a 20-ton ice machine to its factory.

The Batesville Iron Works Co., of Batesville, Ark., will add a foundry to its machine shop.

A Philadelphia company will build a rolling-mill and bolt, nut and rivet plant at Rudford, Va.

The Reymann Brewing Co., of Wheeling, W. Va., will, it is reported, put in a 50-ton ice machine.

The Lexington (Ky.) Brick Co. will probably put in machinery for the manufacture of fire-brick.

The Enterprising Manufacturing Company, at Tallahassee, Fla., will erect a large planing-mill.

J. H. Ellerbee will erect a steam cotton gin at Bronwood, Ga., to be completed by September 1.

It is stated that J. F. Loomis is negotiating for the establishment of an ice factory at Goforth, Ky.

The Moritor Plow Works, Minneapolis, Minn., were recently destroyed by fire, at a loss of $115,000.

The Gorrie Ice Co., of Savannah, Ga., will increase the capacity of its factory by adding a 35-ton ice machine.

It is stated that steel car-wheel works, a steel plant and cement works will be established at Glasgow, Va.

The Chester (Pa.) Rolling-mill Company have voted to increase their capital stock from $600,000 to $1,000,000.

Henry McGurren, of Chicago, Ill., and others have made a proposition to construct the gas-works at Hot Springs, Ark.

The Farmers' Alliance, of Pensacola, Fla., will establish a fertilizer factory. S. S. Harvey, of Molino, is interested.

It is stated that a stock company has been organized, to erect a $25,000 ice factory and fruit cannery, at Winston, N. C.

Barry Coleman and others, of St. Louis, Mo., are reported as about to build a $150,000 rolling-mill in South Pittsburgh, Tenn.

The Deuravant Cotton Manufacturing Company, of Morganton, N. C., contemplates doubling the capacity of its cotton-mill.

The Crystal Ice Company intends adding, this coming fall or winter, a 25-ton ice machine to its factory at Knoxville, Tenn.

McCrocklin & Co. will add a forty-bushels-per-hour corn-mill to their flour-mill, at Taylorsville Ky., also three sets of rolls.

A $100,000 stock company is reported as being organized at Orangeburg, S. C., to erect a cotton factory, cotton gin, grist-mill, etc.

The Raleigh (N. C.) Cotton-mills will, it is reported, issue $50,000 of bonds to complete and put in operation their cotton factory.

Fite & Boston are rebuilding their planing-mill and dry-kiln reported as burned at Resaca, Ga. Their saw-mill was not destroyed.

Balcom & Hurst are erecting an ice factory at St. Petersburg, Fla., with ten tons daily capacity, and will include in it their cold-storage plant.

The W. C. Stevenson Company, of Pittsfield, Mass., manufacturers of bobbins, are to erect a two-story addition to their mill, 34x75 feet.

The Cummings Iron Works, at Hammond, Ind., have been purchased by a syndicate, who, it is said, will increase the plant and employ 500 hands.

The Cummings Iron Works, at Hammond, Ind., have been purchased by a syndicate, who, it is said, will increase the plant and employ 500 hands.

W. M. Neal is corresponding with a London, England, capitalist, with a view to securing the location of a $1,000,000 cotton-mill in Helena, Ark.

The S. R. Smyth and Laughlin Company, of Pittsburgh, Pa., have the contract to build a first-class plant for the Youngstown, (O.) Rolling-mill Company.

The Hilliker-Krebs Building and Manufacturing Co., of Bessemer, Ala., has contract for erection of a machine shop for the Bessemer Pipe Works, 67x140 feet.

Wight, Welosky & Brown and B. F. Wilder have, it is reported, purchased three acres of land in East Albany, and will erect a fertilizer factory at Albany, Ga.

The Ross-Mehan Brake Shoe Foundry Company, of Chattanooga, Tenn., will, it is reported, add a $50,000 malleable-iron plant to its foundry and machine shops.

It is rumored that a new paper-mill is thought of at Mittineague, Mass., to be located between the two Agawam paper-mills, and under the same management.

The Macon Gas Light & Water Co., of Macon, Ga., will increase its water supply 300,000 gallons at once, and will further increase 3,000,000 gallons as rapidly as possible.

The McGuire Machinery Company, Chicago, has been incorporated, to manufacture machinery; capital, $22,000; incorporators, H. McGuire, O. P. Hurford, John Hoinsen.

The Brainard Milling Machine Company, of Hyde Park, is increasing its facilities by the addition of a shop 100x40, a new office and vault for the safe keeping of drawings, plans, etc.

The Morgan Iron Works will build, within the next few months, foundry, machine shops, sash, door and blind factory, and general woodworking establishment, at Spartanburg, S. C.

The pipe-works lately mentioned as to be built at Bessemer, Pittsburgh district, will be operated by the Howard-Harrison Iron Company, which is to be organized with a capital stock of $500,000.

The Kansas City and Mexican Transportation Company (East St. Louis) has been incorporated, to build railroad cars; capital, $500,000; incorporators, A. J. Morris, Henry E. Mills, Herman Ralf.

Philadelphia and New York capitalists have organized the Richmond (Va.) Tube Works, and will establish a large plant, with $500,000 capital. Richland is on the Norfolk & Western Railroad.

The Cinclair Sugar Factory at Brusly Landing, La., is improving its works by erecting hot-room building, 100x120 feet, two stories high, and adding four (6x20 feet) Murphy furnaces and boilers.

The Decatur Ice Co., of Decatur, Ala., will at once increase capital to $30,000, and add a 15-ton ice machine to its plant. Work on building—which will be of brick—will be commenced at once.

The Columbia Iron and Steel Company, among other improvements, is adding two soaking pits to its plant at Uniontown, Pa., which will increase the capacity of the bessemer department 25 per cent.

The Spaulding Iron Works, at Brilliant, Ohio, was offered a second time at public sale on Tuesday last, but there was no buyer. The mill was appraised at $133,000, and was offered for $88,667.

The Belfont Iron Works Company and the Kelly Nail and Iron Company, both of Ironton, Ohio, have definitely decided to erect a steel plant. Work on it will probably be commenced in a short time.

The Marble City Electric Light Company, of Rutland, Vt., is to be reorganized, a new company being formed, with a capital of $25,000, to be known as the Marble City Electric Light and Power Company.

It is reported that the Cramps Ship and Engine Building Company have increased their capital stock to $3,500,000 for the purpose of establishing an immense shipbuilding plant at Philadelphia.

The National Electric Ice Machine Company (Chicago) has been organized, to manufacture ice and ice machines; capital, $1,000,000; incorporators, Frank K. Beggs, William M. McEwen, Grover E. Walter.

The Ludlow Manufacturing Company, Ludlow, Mass., are moving the machinery from the old stone mills into the new mill. The next move will be to pull down the old mills and erect new buildings on the site.

The Murphy & Potts Manufacturing Company, Chicago, has been organized, to manufacture plumbers' materials; capital, $50,000; incorporators, George W. Murphy, Thomas W. Potts, Jesse D. Frost.

It is stated that arrangements are about completed for the erection of a large cotton-mill in South Dallas, Tex., and another on the property of the Dallas Manufacturers' Aid Improvement Company.

The Universal Electric Construction Company (Chicago) has been organized to manufacture and sell electrical machinery; capital, $500,000; incorporators, Charles M. Peale, Edwin Brainard and Frederick H. Wood.

A branch factory of the South Boston Iron Works will be established at Middlesborough, Ky., for the manufacture of heavy ordnance, pneumatic gun carriages, chilled steel products and heavy armor for the Government.

The George L. Thompson Manufacturing Company, Chicago, has been organized, to manufacture machinery, hardware and novelties; capital, $25,000; incorporators, George L. Thompson, David M. Mills, William Henry Gorman.

The Bessemer (Ala.) Machine and Foundry Co. has been incorporated. The capital stock is $100,000, with privilege to increase to $250,000. The incorporators are J. P. and G. W. Beggs, of Bessemer, and J. E. Lee, of Quitman, Ga.

The Pond Engineering Company, of St. Louis, write us that in order to handle their increasing business in Texas and on the Pacific coast to better advantage, they have opened an office at Dallas, Tex., and one at Seattle, Wash.

The Apollo (Pa.) Iron and Steel Company is building a new 24-inch mill at Apollo, and will, probably in about a month, erect a second one. With the addition of the two mills the product will be increased about 400 tons per month.

The Borden Stationery Company, of Adams, Mass., have decided to move their entire works to Fairfield, Mass. A building, 50x150 feet, is to be built for the company's occupancy, adjoining the mill of the Fairfield Paper Company.

The Hardy High-speed Engine Company, of Chicago, has been incorporated, to manufacture and deal in steam engines and other machinery; capital, $100,000; incorporators, Mark P. Leonard, Malcolm N. Owen and Lewis G. Blossom.

Fraser & Chalmers, of Chicago, have taken out the requisite permits for the erection of new two and four-story foundries on West Twelfth street, to cost $150,000, and a one-story boiler shop on Washtenaw avenue, to cost $80,000.

R. D. Frayser, William Katzenberger, Albert Seessel and others have incorporated the Consumers' Mutual Ice and Cold Storage Company, to erect an ice factory and cold-storage warehouse, at Memphis, Tenn. The capital stock is $150,000.

It is stated upon pretty fair authority that the Columbia Iron and Steel Company, and the Pennsylvania Construction Company, of Uniontown, Pa., have been sold to an English syndicate. No change will be made in the operations of the plant.

The Lebanon (Pa.) Iron Company has just put in operation a twelve-inch bar-mill, built by the Lewis Foundry and Machine Company, of Pittsburgh. It is equipped with two Stubblebine gas-heating furnaces, and is placed in a new addition of 100x300 feet.

A. J. Lyman, the National Electric Manufacturing and Construction Company, J. E. Dickerson and others, have incorporated the People's Light, Heat and Power Company, to erect an electric light and power plant, etc., at Asheville, N. C. The capital stock is $50,000.

The Standard Chemical Company, whose works are on Staten Island Sound at Traunley Point, N. J., are about to double the capacity of their plant. The company have purchased 2½ miles of waterfront, and when the improvements are completed will give employment to 400 men.

The transfers have been made of nearly forty acres of land south of the Calumet Iron and Steel Company's mills at Cummings, Ill.; cost, $385,000. The purchasers are Washburn, Moen & Co., wire manufacturers. Several hundred thousand dollars will be expended on the improvements.

The plant of the Lookout Rolling-mill, which is shortly to be removed from Chattanooga, Tenn., to New England City, Ga., will be considerably enlarged, and several extra trains of rolls, additional engines for driving them, more puddling and heating furnaces and a large machine shop will be added.

One of the new enterprises at St. Louis is the St. Louis Steel Foundry Company, whose works are located at East St. Louis. The foundry is 150x120 feet, and it is thought that a force of sixty men will soon be required. The company is able to turn out castings up to 1,500 pounds in weight of crucible steel.

The Crescent Soda and Salt Co., of Cloverport, Ky., has been incorporated with $1,000,000 capital stock, and will either erect works at Cloverport or Brandenburg for manufacture of soda ash on a large scale. The works are to be completed in four months. Bennett H. Young, of Louisville, is president.

It is stated that the Jacksonville Mining and Manufacturing Co. has completed negotiations with eastern and foreign capitalists for the building of large steel works, to include rolling-mill, steel-mill, etc., at Tredegar, Ark. The company which proposes erecting the plant also intends constructing a system of water-works.

William Tod & Company, of Youngstown, Ohio, are building two compound non-condensing engines—one of 100 H. P. and one of 200 H. P.—for the Youngstown Electric Light Company. They are of the tandem type, and with cylinders 8 and 15x15 and 12 and 21x21. The automatic governor used on these engines is a governor of their own design.

The machine works of Joseph C. Todd, Paterson, N. J., were recently destroyed by fire, entailing a loss of about $150,000, and throwing 160 men out of employment. It is understood that the works will be rebuilt at once. These were the principal works in the United States where hemp and rope machinery was made, a good deal of which was exported.

Mr. W. H. Ermentrout has broken ground for the erection of a three-story brick machine shop at Reading, Pa., in which he intends to do general repair work, and also manufacture several specialties, such as valve-motion models, tube-cutters, a patent ratchet, etc. Mr. Ermentrout writes that he hopes to have the building under roof by the 1st of September.

A new bucket to be used in connection with excavators and dredges, and for handling coal, has been invented by McBride Bros., of Philadelphia, and is to be seen in operation at McBride's wharf, Port Richmond, Philadelphia. It is self-filling and self-dumping, and, it is claimed, has numerous advantages over those now in use. A company is to be organized to introduce it.

The new plant of the Greensburg Steel Co., located at Huff Station, Pa., is now in operation. The plant contains a single and a double heating furnace, one welding furnace and a 24-pot crucible furnace, and is equipped with a 600-pound and 1,200-pound hammer. The firm manufactures tool steel exclusively, and when in full operation will turn out about three tons per day.

The extensive steel plant which is to be erected at Jacksonville, Alabama, will cover twenty acres of ground, and when all departments of the plant are in full operation it will give employment to more than 3,000 people. Steel is not alone to be manufactured; the entire product of the great enterprise will be converted into plows, hoes, hammers, hatchets, and all kinds of useful implements.

J. H. Coram is erecting a fine brick building on the site of the recent Western avenue fire at Lowell, Mass., to be used exclusively for manufacturing purposes. The building will be four stories high, 130x75 feet. A separate building will be erected for boilers and engine, which will be made as nearly fireproof as possible. The building will be thoroughly equipped with sprinklers and fire extinguishers.

The Hudson River Water Power and Paper Company, at Mechanicville, N. Y., of which Timothy Merrick, of Holyoke, is president, will, within two months, begin the erection of a new pulp-mill and a paper-mill for the manufacture of sulphite pulp and paper. The plant will be located near the present works. This company is composed largely of Hartford (Conn.) capitalists, and has been doing a large business. The present plant turns out dry and wet chemical fiber.

A large force of hands is now employed in the mills of the Ray Woolen Company, North Bellingham, Mass., in tearing out portions of the old equipment, to be replaced by the latest modern machinery. None of the machinery has been in use over ten years, but constant use during that time has rendered it incapable of producing the best results. Parties from Pittsburgh are at the mills, engaged in putting in an electric light plant of 30 horse-power for use in the mills and print works.

The Pottsville Bridge Company is a new concern, organized to carry on a bridge-building business at the works of the Pottsville Iron and Steel Company. The president is William Atkins, treasurer and superintendent of the Pottsville Iron and Steel Company; vice-president and engineer, H. L. Forte; treasurer, John M. Callan, secretary of the Pottsville Iron and Steel Company. The main office of the company will be 426 South Fourth street, Philadelphia, and the works at Pottsville, Pa.

A new company, known as the American Brass and Rivet Company, has just been organized at Westfield, Mass., in connection with the firm of Williams & Van Duesen, manufacturers of whip buttons, ferrules, etc. The capital stock is $50,000 Subscribers to the $40,000 for buying the plant of the Westfield Plate Company at Thompsonville, Conn., a deal recently fallen through, are to investigate another manufacturing enterprise for the purpose of taking stock in it, and securing its removal to Westfield.

There have been several rumors during the past week of new factory buildings to be erected in Framingham, Mass. One is that a new shoe factory is to be built, 300x45 feet, three stories high, on land in Waverly street, the building to be occupied by a Spencer or Brookfield firm. An old story is that the Para Rubber Works are to be enlarged, so that different kinds of hard rubber goods could be manufactured. It has also been stated that the Marston Bed Factory was to be doubled in size. Inquiry at the factory shows that more room will soon be needed.

The Aerated Fuel Company's system has recently been placed in the works of the Keystone Watch Case Company, 19th and Brown streets, Philadelphia, Pa., for melting brass, copper and other metals in crucibles, and also for annealing and other lines of work. In melting metals in crucibles it is found that the melts can be obtained in considerably shorter time than with a coal fire, besides the other advantages attendant on oil fuel. W. S. Collins, licensee of this system in the eastern part of the middle States, has recently removed his office from 171 Broadway to 814 Temple Court, New York.

The scheme for putting up a building in Hartford, Conn., for furnishing quarters and power to small manufacturers, has gone into effect, and a big shop will soon be erected on Capitol avenue. Successful manufacturers are handling the movement, and a company has been organized, with a capital of $100,000. A site of three acres has been purchased, and it is proposed to erect a building 50x350 feet, three stories high, room being left for an additional building of about equal size. The structure will be furnished with every modern improvement, and it is estimated that it will cost, without the land, a little over $50,000; with the land about $70,000.

The old Phœnix Mill property, at Shirley, Mass., two years ago was purchased by the Samson Cordage Company, of Boston. J. P. Tolman, of Newton, is president and manager; S. W. Longley, clerk and superintendent. The company manufactures several varieties of braided cord, of cotton, hemp and linen. The cords are braided with fifteen strands, each strand locking four others at each stitch, making a hard, smooth surface. For several months past they have been crowded with orders, and have added machinery and help to fill them. They now employ over one hundred hands, and plans are now being made to double the mill's present size.

A new industrial concern, with Westfield, Mass., men among its leading stockholders and managers, has just been formed, under the corporate name of the Gas, Heat and Power Company, with a capital stock of $500,000, to manufacture machines and build retorts for the production of illuminating gas from crude petroleum for lighting, heating and power. An experimental retort has been in operation for some time at Portland, Me., and proved so successful that capitalists have taken hold of it. The corporation is chartered under Maine laws, and at the meeting for organization last week, A. D. Warren, of Worcester, was chosen president, and W. P. Warren, of Westfield, treasurer.

D. H. & A. B. Tower, of Holyoke, Mass., have completed plans for the new pulp-mill of the Manufacturing Investment Company at Madison, Me. They show a mill of a capacity of forty tons pulp per day, but only enough of the building will be built this season to turn out twenty tons per day. An idea of the size of the mill may be arrived at by the statement that it will be over a half mile around the foundations. It will require 351,000 feet of plank to plank in the roofs. The dimensions of the several rooms will be as follows: Wood-preparing-room, 138x135 feet; wheel-room, 166x155; digest-house, 243x68; washing-room, 218x74; machine-room, 162x80; length of building, 630 feet; upwards of 5,000,000 of bricks will go into the build of the mill. The building is to be started at once, and the roof must be on before fall. It is to be of brick and hard pine wholly.

The foundry of the Atherton Machine Company, Lowell, Mass., was recently burned. It covered about 11,000 square feet, was isolated from the other buildings, and caught probably from the furnace. The building was a one-story brick structure, with a wooden roof. The fire was confined to the foundry; the property destroyed, beside the building, consisted of the furnaces, patterns and flasks. The treasurer, A. A Coburn, stated that the insurance is in a blanket policy written by the Manufacturers Mutual Company, but that the loss on building and contents may be in the neighborhood of $28,000. The fire will not greatly interfere with orders, as most of the patterns were stored in another building, and many in use were saved. The coal sheds with a couple of car-loads of coke, adjoining the foundry, were also burned. Mr. Coburn has already taken steps to secure plans for a new foundry to take the place of the one destroyed. The new building will be of brick with an iron roof, and will be more compact than was the building destroyed. The building formerly used to clean the castings in will be cleared and converted into a temporary foundry, and ten men will be pouring metal there to-day. A number of patterns of work ordered by Lowell corporations and others were lost in the fire, making a very aggravating loss.

A special to the *Boston Daily Advertiser* says: The new pulp and paper plant that is being erected at Lisbon Falls by Maine and New York capitalists will be one of the largest in the country. The work is well under way and the company will endeavor to begin business in November. The buildings are all one-story with monitor roof; the digestor building, however, has three floors. The paper-mill is 268x108 feet, machine-room building 100x49 feet, boiler-house 71x41 feet, digestor-building 77x40 feet, wood-room 84x46 feet, and chemical-room 74x61 feet, all built of brick. A chimney 119 feet will furnish draught for several engines of 725 horse-power. The pulp will be made by the sulphite process, and a large amount of heavy machinery is now being made for the plant. Two clippers, each weighing two tons, are now being built at Fitchburg. These machines will clip twenty-five cords a day, and run about 800 revolutions a minute. The four digestors are now being built at the Bath Iron Works, and each will weigh 45 tons when completed and set in position. Costly machinery has been purchased for the chemical-room. A three-cylinder pulp machine, to cost $3,500, will be put in. For the paper-mill, six 1,000 pound Horne and two Jordan engines have been ordered. Two paper-machines, costing $20,000, will also be put in. The pulp-mill will have a capacity of about 12 tons of dry pulp per day. This will be used in the paper-mill for the manufacture of fine book and envelope paper, and about 15 tons will be turned out daily. All the pulp made will not be used at first by the paper-mill, but part of it will be shipped to market. It is stated that the company proposes to have things so arranged that twenty-four hours from the time a spruce log is put in at one end of the mill it will be packed in the freight cars at the other end in the form of book paper. The preparation of the acids and the cooking of the wood in the digestors, as performed in this plant, will be new and important steps in the sulphite process. Five waterwheels will be put in, with an aggregate of 720 horse-power.

Force, Motion and Work.

By Pedro.

FOURTEENTH PAPER.

COMPOSITION AND RESOLUTION OF FORCES.

In the seventh paper we studied the composition and resolution of motion. We have seen that any two component motions may be represented by the sides of a parallelogram, both in direction and magnitude, and that the diagonal of the parallelogram represents the resultant motion in direction and magnitude. In the tenth and twelfth papers we have seen that the static and dynamic forces of a body are both proportional to the velocity imparted to it; hence we conclude that they can be represented, composed and resolved in the same manner as motion.

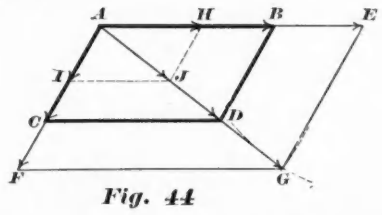


Fig. 44

If, in Fig. 44, $A\ B\ C\ D$ is a parallelogram of motion, $A\ B$ and $A\ C$ being the component velocities, and $A\ D$ the resultant, then, by increasing or decreasing these in the ratio of the velocity to the force, as $A\ E$, $A\ F$ and $A\ G$, or $A\ H$, $A\ I$ and $A\ J$, the diagram becomes a parallelogram of forces —static or dynamic.

This can be easily proved by assuming a body of any weight, w, to be acted on by three forces or pressures, imparting so many different velocities to it. From Equation 48, twelfth paper, we have for the three dynamic forces

$$F_1 = \frac{w\ V_1}{g}.$$

$$F_2 = \frac{w\ V_2}{g}.$$

$$F_3 = \frac{w\ V_3}{g}.$$

Dividing, we get

$$\frac{F_1}{F_2} = \frac{V_1}{V_2} \text{ and } \frac{F_1}{F_3} = \frac{V_1}{V_3}.$$

Now, if the parallelogram of velocities $A\ B\ C\ D$, in Fig. 44, represents the three velocities, viz.: $V_1 = A\ B$, or $C\ D$, $V_2 = A\ C$ or $B\ D$ and $V_3 = A\ D$, then we have

$$\frac{F_1}{F_2} = \frac{A\ B}{B\ D} \text{ and } \frac{F_1}{F_3} = \frac{A\ B}{A\ D}.$$

Now, making $A\ E = F_1$, $E\ G = F_2$ and $A\ G = F_3$, and substituting above, then we have

$$\frac{A\ E}{E\ G} = \frac{A\ B}{B\ D} \text{ and } \frac{A\ E}{A\ G} = \frac{A\ B}{A\ D}.$$

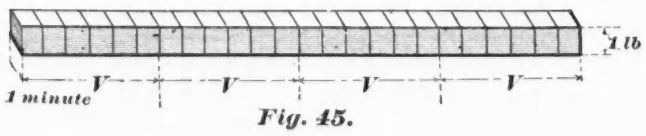


Fig. 45.

These cannot be true equations unless $E\ G$ is parallel to $B\ D$, and $A\ G$ parallel to or coinciding with $A\ D$, so as to make $A\ B\ D$ and $A\ E\ G$ similar triangles. The same is true of the triangles $A\ C\ D$ and $A\ F\ G$; hence $A\ E\ F\ G$ is a parallelogram of dynamic forces, having its sides respectively parallel to the parallelogram of velocities $A\ B\ C\ D$.

By the same process we can prove the parallelogram of static forces $A\ H\ I\ J$, by means of Equation 46, twelfth paper. Hence the principle of "composition and resolution" is general, whether it relates to motion, static or dynamic force.

We see, then, that, although the real geometrical equivalent of dynamic force is a *volume*, it may be represented either by a plane, Equation 45, twelfth paper, or even a simple straight line but in either case the number expressing the value of the force is really the *volume*, and not the surface or the straight line. We can see that it may be represented by a plane, by Equation 45, twelfth paper, which has the form of an equation of a surface whose sides are v and V, because the thickness of the volume is unity; hence the number of units in the volume (Fig. 34) is the same as the number of units in half the surface $B\ C\ G\ H$.

Again, if we take the six rows of blocks in Fig. 31, and place them end to end, as in Fig. 45, the same as we did in the case of motion (sixth paper) we shall have a row of blocks, or number of units of dynamic force, which is the same as the number of units in a straight line of the same length; that is, the straight line, or the plane and the dynamic force, are numerically equal, but not physically. Hence we may represent dynamic forces by straight lines as long as we are seeking for their numerical values, their physical quality being borne in mind.

To illustrate the principle of the composition and resolution of forces, let us solve several examples:

Example 1.—A belt (Fig. 46) drives a pulley, A. The angle between the two sides of the belt is 30°. The tension on the driving side of the belt is 200 pounds, and on the slack side 66 pounds. What is the pressure upon the bearings of the pulley?

From the center A, of the pulley, draw the lines $A\ B$ and $A\ C$ parallel to the sides of the belt respectively, and make $A\ B$ equal to 200 pounds, according to some convenient scale. Make $A\ C = 66$ pounds on the same scale, and complete the parallelogram $A\ B\ C\ D$. The diagonal $A\ D$ gives the resulting pressure on the bearing, both

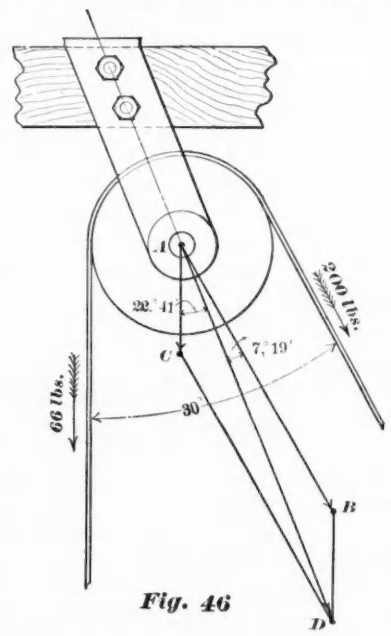


Fig. 46

in direction and in amount. In this case it is 259.3 + pounds acting at an angle of 7°, 19' with the driving side of the belt. This is a parallelogram of static forces.

All such problems can be solved mathematically, sometimes in less time, and always more accurately than by the graphical method. For example, in Fig. 46 we have, in the triangle $A\ B\ D$, angles $A\ D\ B + D\ A\ B = 30°$. By a trigonometrical formula we have

$$\tan.\ \tfrac{1}{2}\ (A\ D\ B - D\ A\ B) = \frac{(A\ B - B\ D)\ \tan.\ \tfrac{1}{2}\ (A\ D\ B + D\ A\ B)}{A\ B + B\ D} = \frac{134\ \tan.\ 15°}{266}.$$

From which we get

$$\tfrac{1}{2}\ (A\ D\ B - D\ A\ B) = 7°,\ 41',\ \text{also}$$

$$\tfrac{1}{2}\ (A\ D\ B + D\ A\ B) = 15°.$$

Adding and subtracting we get $A\ D\ B = 22°,\ 41'$, and $D\ A\ B = 7°,\ 19'$.

By trigonometry we also have

$$\frac{A\ D}{A\ B} = \frac{\sin.\ A\ B\ D}{\sin.\ A\ D\ B}$$

or the resultant

$$A\ D = \frac{A\ B\ \sin.\ A\ B\ D}{\sin.\ A\ D\ B} = \frac{200\ \sin.\ 30°}{\sin.\ 22°,\ 41'} = 259.3 + \text{pounds}.$$

Example 2.—A beam (Fig. 47) is leaning against a wall, making an angle of 30° with a vertical line. A weight of 600 pounds is suspended from it. What is the direct compressive strain on the beam produced by the weight, and what is its bending strain?

From the point of suspension, A, draw an indefinite line $A\ C$ in the direction of the beam, which is the direction of the compressive strain. Also draw the line $A\ B$ at right angles to the beam; this is the direction of the bending strain. Now lay off $A\ D$ in

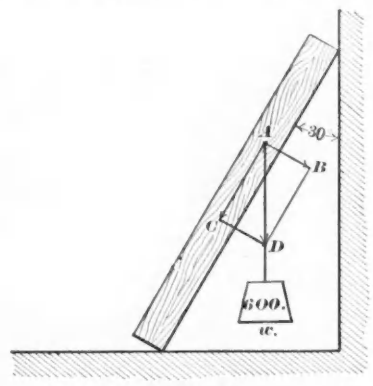


Fig. 47

the direction of, and equal to the weight, 600 pounds. From the point D draw $D\ B$ and $D\ C$ respectively parallel to $A\ C$ and $A\ B$, then will $A\ B$ and $A\ C$ be the component pressures, the resultant of which is the weight, $A\ D$. $A\ B$ is the bending strain, and is equal to 300 pounds, and the compressive strain, $A\ C$, is 519.62 pounds.

Mathematically $A\ B = A\ D$ sin. $A\ D\ B = 600.$ sin. $30° = 600. \times \frac{1}{2} = 300.$ pounds.

$A\ C = A\ D$ cos. $C\ A\ D = 600$ cos. $30° = 19.62$ pounds. This is an example of the resolution of static force.

Example 3.—A ball, A, Fig. 48, is falling with a dynamic force of 19,296 pounds at any given time; at the same time the wind pressure is causing it to move at right angles with its line of fall, with a dynamic force of 200 pounds. What is the resulting dynamic force?

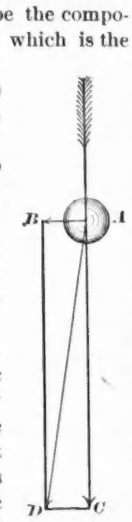


Fig. 48

The resulting dynamic force $A\ D$, Fig. 48, is the diagonal $A\ D$ of the parallelogram, whose sides $A\ C = 19{,}296.$ and $A\ B = 200$.

Mathematically, $A\ C = 19{,}296.$, $A\ B = D\ C = 200.$, and

$$A\ D = \sqrt{A\ C^2 + D\ C^2} = 19{,}297.04 \text{ pounds}.$$

This is an example of the composition of dynamic force.

It is a day of exceedingly low temperature, so to speak, when some new invention is not invented for the prevention of collisions on railroads. The latest is said to come from Austria, and it is seriously announced that glass tubes project in front of the train, which, when broken by meeting an obstacle, cause an electric brake to be applied. If you will notice, electricity always plays an important part in these matters. Every practical railroad man will see at once the beauty of the idea of having glass tubes projecting in front of the engine to a sufficient distance to enable the train to be stopped after the tubes come up against something. Now, perhaps things could be arranged so that, after each prevention of a collision in this way, the fragments of glass tube could be gathered up and used for gauge glasses. We charge nothing for this idea.

There have been many failures of boilers in the British navy under the operation of forced draught; this is accounted for by the Chief Inspector of Machinery as follows:

The intense heat in the combustion chambers and tubes, generated by the "blow-pipe" action of the forced draught, quickly evaporates the water in contact with the plates, and great quantities of steam are given off from them. The steam, in passing through the water, lifts it to some extent away from the plates, so that what is in contact with them is not water, but a mixture of water and steam, and while this is sufficient to prevent serious softening and bulging of the plates, it does not prevent so much overheating as to make the tubes and stays give way under the strain due to end-on expansion of the furnaces and tubes.

The inspector advocates the use of larger boilers, that will supply full steam with a very low air pressure—equal to one-half inch of water.

Steel Rivets.

Mr. H. C. Torrance, representing the Oliver Iron and Steel Works, read a communication at the meeting of the American Boiler Manufacturers' Association in New York, July 2, 1890, in which he gave the following results of tests made by the United States Government of the shearing and tensile strength of forty-five steel rivets. The rivets were driven hot, and the shearing tests made in single shear:

TENSILE TESTS.			SHEARING TESTS.			
Average diameter of specimen.	Average tensile strength per square inch	Average elongation in eight inches.	Nominal diameter of rivet.	Average shearing strength per square inch.	Number of tests.	Shearing strength per cent of tensile.
Inches.	Pounds	Per Cent.	Inch.	Pounds.		Per Cent.
.624	51 660	31.12	$\frac{5}{8}$	41,800	9	81
.616	55,925	29.94	$\frac{5}{8}$	57,963	6	104*
.753	58,573	29.56	$\frac{3}{4}$	47,983	6	82
.756	60,250	29.75	$\frac{3}{4}$	52,248	6	87
.869	56,370	29.37	$\frac{7}{8}$	50,601	6	90
1.113	56,510	31.17	$1\frac{1}{8}$	57,177	6	101*
1.246	55,390	30.60	$1\frac{1}{4}$	49,004	6	88

* These sets of rivets may have been hammered at a low heat, which would account for the abnormal results. Omitting these figures, the shearing strength averages 85.6 per cent. of the tensile strength.

The Government requirements for the rivets used in boilers of the new cruisers are: The rivets for use in the longitudinal seams of boiler shells shall have from 58,000 to 67,000 pounds tensile strength, with an elongation of not less than 26 per cent. in 8 inches, and all others shall have a tensile strength of 50,000 to 58,000 pounds, with an elongation of not less than 30 per cent. They shall be capable of being flattened out cold under the hammer to a thickness of one-half the diameter, and of being flattened out hot to a thickness of one-third the diameter, without showing cracks or flaws. The steel must be made by the open-hearth, or Clapp-Griffiths process, and must not contain more than .035 of one per cent. of phosphorus, nor more than .04 of one per cent. of sulphur.

A lot of twenty successive tests of rivet steel of the low tensile strength quality, and twelve tests of the higher tensile strength, gave the following results:

	Low Steel.	Higher.
Tensile strength, lbs. per square inch	51,230 to 54,100	59,100 to 61,850
Elastic limit, lbs. per square inch	31,050 to 33,190	32,080 to 33,070
Elongation in 8 inches, per cent	30.5 to 35.25	28.5 to 31.75
Carbon, per cent	.11 to .14	.16 to .18
Phosphorus	.027 to .029	.03
Sulphur	.033 to .035	.033 to .035

As the safest steel rivets are those of the lowest tensile strength, since they are the least liable to become hardened and fracture by hammering, or to break from repeated concussive and vibratory strains to which they are subjected in practice, the low tensile strength rivet should in general be specified for ordinary boiler work. For calculations of the strength of riveted joints, the tensile strength may be taken as the average of the figures above given, or 52,665 pounds, and the shearing strength, according to the table of shearing tests, may be taken at 85.6 per cent. of the tensile strength, or 45,081 pounds; in round figures, 45,000 pounds per square inch.

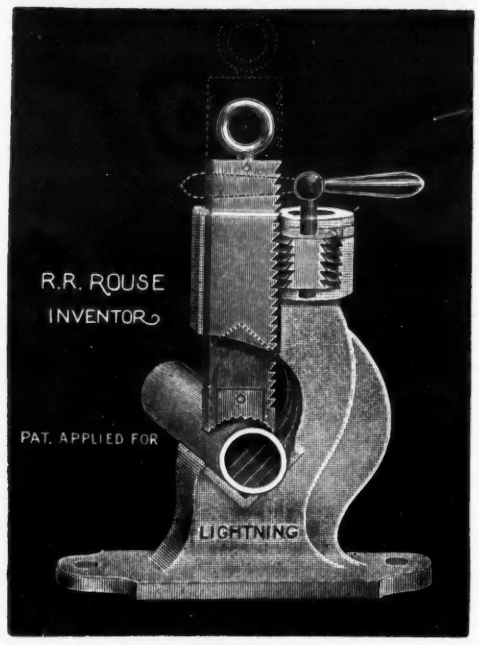
We have received a copy of a special consular report entitled, Files in Spanish America. It seems that some American makers of files wished to know what prospect there might be for working up an export trade with Spanish America, and to that end submitted to the Department of State a number of inquiries to be forwarded to consuls, and to be answered by them. We do not find in the report much encouragement for American file makers in that quarter. There seems little demand in most sections for files of any kind, and most of those imported are of English and German manufacture, which, though thought to be inferior to American files, are so much cheaper that it would probably be difficult to supplant them.

Ground has been broken at Fordham Heights for what is to be known as Webb's Academy and Home for Shipbuilders. William H. Webb was a famous American shipbuilder before the war—famous not only in this country, but in Europe as well—and he made a large fortune at the business. Now he has determined to spend a remarkably generous part of this fortune in providing instruction, free of all cost, to young Americans who have natural talent that way, and who are desirous of learning the rudiments of shipbuilding and of marine engine building. Also to provide a home for aged and indigent shipbuilders and marine engine builders, and their wives. The carrying out of Mr. Webb's plans will involve an expense of several million dollars, and will rank amongst the greatest benefactions in the world.

A New Pipe Vise.

The engraving on this page shows a new form of pipe vise, which is being introduced by Montgomery & Co., 105 Fulton street, New York. The engraving so clearly shows its construction and method of operation, as to make an extended description unnecessary. As will be seen, a turn of the short lever brings a blank portion of the screw next the bar, and leaves the threads disengaged, so that the vise may be adjusted to the pipe, when a reverse motion of the lever tightens it. Ratchet threads are used to avoid side thrust and unnecessary friction. It weighs 15 lbs., and will hold pipe from $\frac{1}{8}$" to $2\frac{1}{2}$".

It is said that many of the people who thought they were most bitterly opposed to the enactment of the Saturday half-holiday law here in New York State, are now most heartily in favor of it, having found that its benefits are all that was claimed for it, while the objections turned out to be almost wholly imaginary. The old saw, regarding the effect upon Jack of all work and no play, has more meaning than many are disposed to admit, until forced to do so. A Saturday half-holiday has been the rule in Canada for years, and has worked well. Is our country and our labor so much less productive than that of Canada that we cannot give ourselves the weekly half-holiday during the warmer months?



A person of an observant turn of mind, who visits machine shops much, cannot fail often to observe inappropriateness in the placing of tools—large tools where small ones ought to be, and *vice versa;* certain tools so placed as to require unnecessary handling of work in getting it to and from them, and in other ways unhandy.

This is not generally from lack of skill in setting the tools in the first place, but from the necessity of adding tools not originally intended to be used—tools which it was not expected would be required in the business contemplated. But circumstances have made it advisable to branch out in business in directions not originally thought of, and tools for the purpose have been hurriedly placed in vacant spaces. There are shops—not a few of them—where this has been done, in which a large saving would be effected by a general pulling up and re-setting of tools, with the eternal idea of *handiness* in view. Modern planning of the interior of a machine shop takes into consideration the least handling of material to bring about the desired end, and when an old shop, by continued addition of tools not at first provided for, gets in an opposite condition, there are just as good reasons for a general re-arrangement as there is for spending a good deal of time in making the arrangement satisfactory in building a new shop.

A correspondent of the New York *Tribune* at Saint Etienne, France, writes of a remarkable gun invented by Mr. Paul Giffard. The charge is a single drop of a volatile liquid, which develops, by vaporizing, the necessary pressure to propel the bullet. This liquid is contained in a steel shell with a valve so arranged as to be opened and permit a drop to escape behind the projectile. The shell is said to contain three hundred charges. There is no smoke, no heating and fouling of the gun, and but very little noise. The correspondent's story looks like a large one.

About this time of year we expect to see many accounts in the newspapers of fires and fatal accidents, said to result from the explosions of gasoline stoves. In this connection our contemporary, the *American Artisan,* says: "There never was an explosion of a gasoline stove, and there never can be one." It says, further, that there is a tendency among the callow youth who supply associated press telegrams to ascribe every fire which takes place in a house where there is such a stove, to an explosion of the gasoline stove. Sometimes, by carelessness, the oil from these stoves is allowed to overflow and become ignited, when, of course, there is a fire, the same as there would be if any other oil were spilled and ignited. But the stove will not explode.

Machinists' Supplies and Iron.

New York, August 2, 1890.

Iron—American Pig—The market continues quiet, almost no new business being transacted. The leading furnaces are kept busy, however, on contracts, and there seems little anxiety to sell. So far as it seems possible to judge, prices seem likely to be well maintained throughout the year.

We quote Northern No. 1 Foundry, $17 to $18; No. 2, $16 to $17. Southern No. 1, $17 to $17.25; No. 1, Soft, $16.50 to $16.75; and No. 2, $16 to $16.25.

Scotch Pig—The demand has been moderate. We quote Eglinton, $19.25 to $19.75; Dalmellington, $21 to $21.50; Coltness, $23.50 to $24.

Bar—The demand has been fairly good, and the market firm.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—The demand continues very active, and prices still show an upward tendency, especially for future deliveries. Ruling prices are 17¼c. to 17½c. for near-by deliveries, and 18c. for future delivery.

Lead—The market has been very dull, and prices have fallen somewhat, being now at about 4.45c.

Spelter—The demand has been moderate, but sellers have been firm.

We quote ordinary brands of Western, 5.45c. to 5.60c. Choice, 5.70c. to 5.75c. Refined, 6.75c. to 7c. Silesian, 7c. to 7.25c.

Tin—The market has ruled dull, but steady, though there have been indications of weakening. Values range from 20.90c. to 21c.

Antimony—The supply of Regulus seems somewhat limited, and prices have, therefore, been firmly held. We quote Hallett's, 21c. to 21¼c.: Cookson's, 23¾c. to 24c.

Lard Oil—The demand is moderate, and it is selling at 49c. to 50c. for prime.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Mechanical draftsman desires situation; three years' experience. Address Box 54, Am. Machinist.

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Wanted—A first-class draftsman for designing engine and general work. State age, salary and references. Robt. Wetherill & Co., Chester, Pa.

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Foreman of a machine shop is open to an engagement; large experience in both heavy and small work. J. H. B. Bryan, Chester, Pa.

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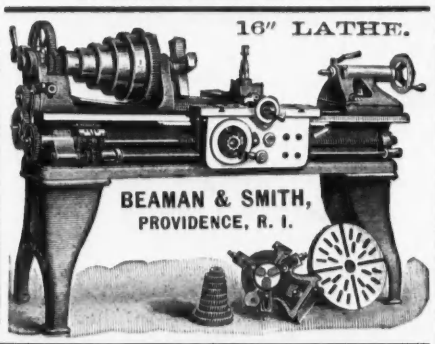

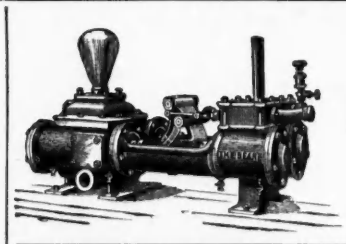

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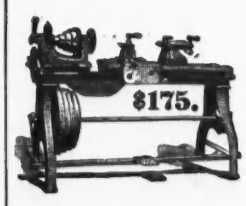

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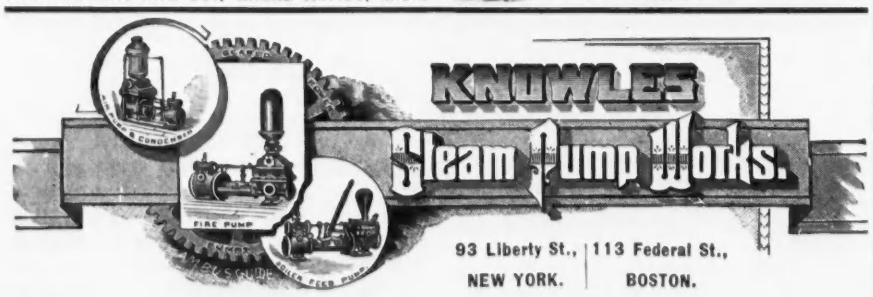

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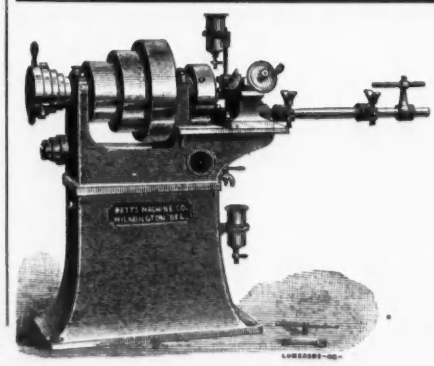

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Wanted — Good machinists; vise or machine hands; steady work and good wages to first-class men Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—A boiler-shop foreman, capable of handling one hundred men on marine work. Write, stating terms and giving references, to Box 55, AMERICAN MACHINIST.

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Mechanical engineer, with good knowledge of machinery and drafting, desirous of an opening with ice-machine mfr. in N. Y. or vicinity. Apply J. D. D., Belleville, N. J.

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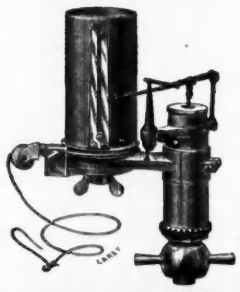

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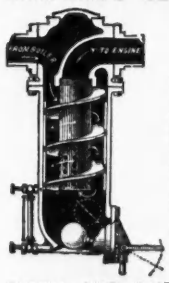

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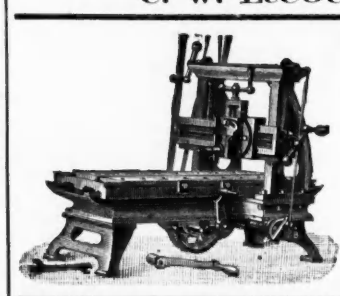

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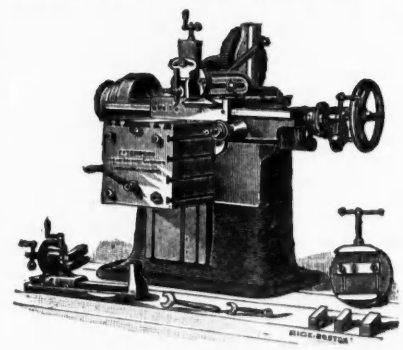

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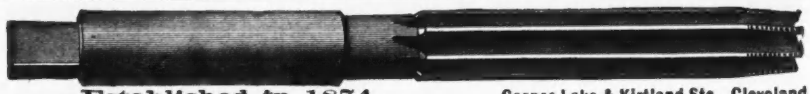

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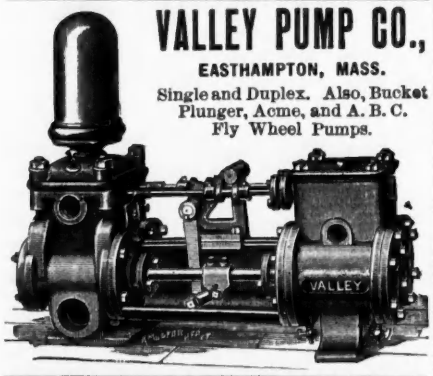

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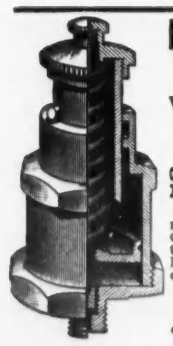

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1886.

Pattern Making, Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast-iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec. 18.
Foundry Practice, Articles on. By S. Bolland, May 8, 22. 29, June 26. July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H. Babcock and C. A. Smith. July 3, 24, Aug. 7. 14, 21. Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives. Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith. Aug. 7.
Making a Cast-iron Sheave. By P. S. Dingey, July 31.
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Core Oven with Rotating Back. By Thos. Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose July 24.
Gating, Clamping and Securing Chaplets. By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C. O. Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov 20.
Making Pattern for Spiral Grooved Drum. By Geo Allge, Aug. 14.
Rolling Conic Sections Applied to Gears. By Geo. B. Grant, Nov. 6.
Ninety-inch Belpaire Fire-box Boiler, Nov. 6.
Spacing in the Milling Machine. By Chas. S. Beach, Aug. 21.
Engine Crossheads. By J. G. Tramis, Aug. 21.
Traction and Adhesion. By A. B Ropes, Aug. 28.
Internal Key-seating on Milling Machines. By A. B Landis, April 17.
Tapping Holes in Boilers. By A. B. Landis, April 24.
How to True Emery Wheels. By L. Best, April 24.
Work and System in the Drawing-room. By C. L. Redfield, Aug. 28.
Oiling Lathe Carriage Ways. By Wm. H. Bradt, Aug. 28.
Moulding a Screw or Worm without Cores. By George Allge. Sept. 11, 18.
Power Absorbed in Cutting Cast-iron. By James F. Hobart. Sept. 11, 18.
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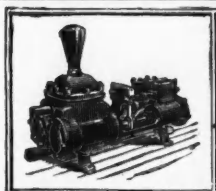

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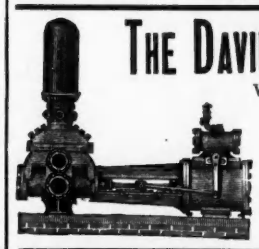

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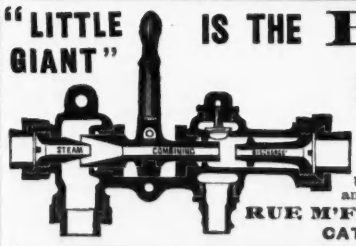

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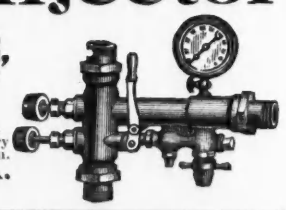

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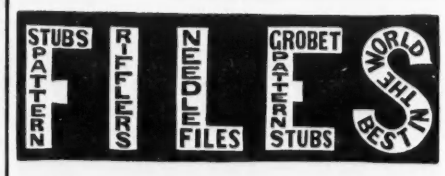

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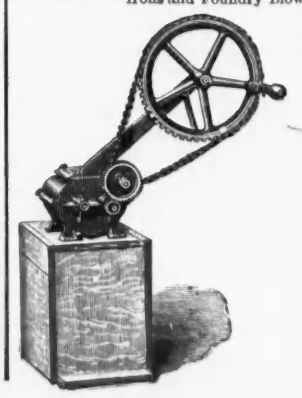

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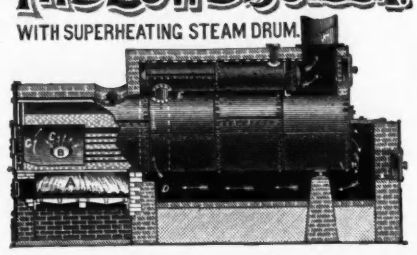

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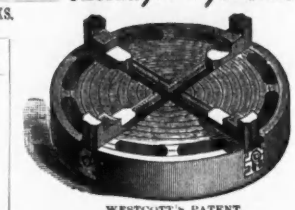

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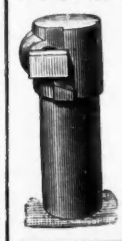

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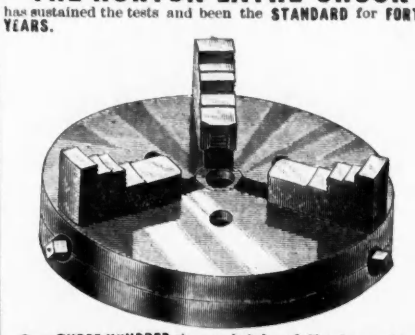

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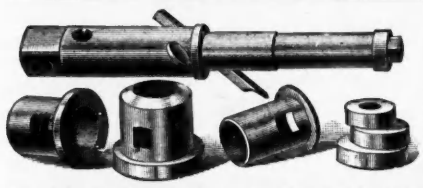

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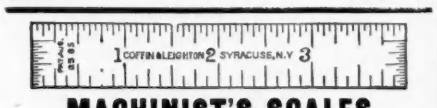

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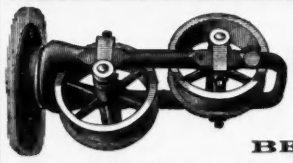

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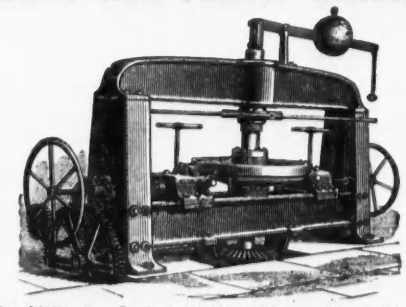

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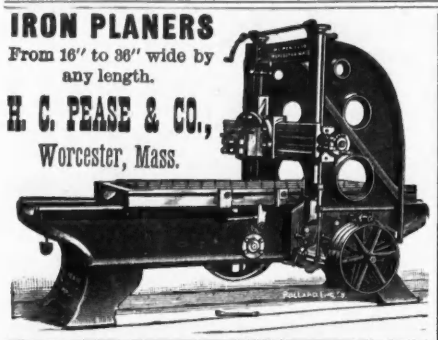

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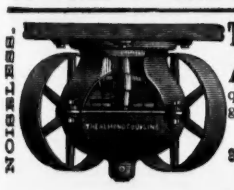

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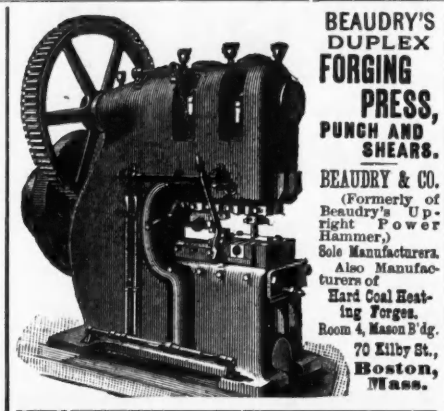

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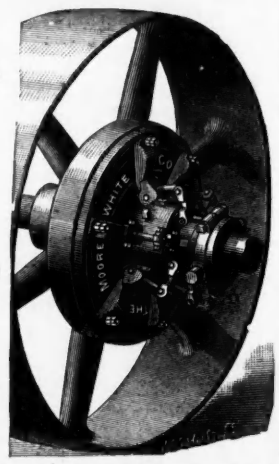

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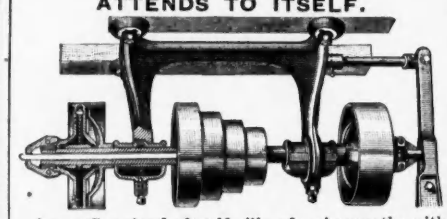

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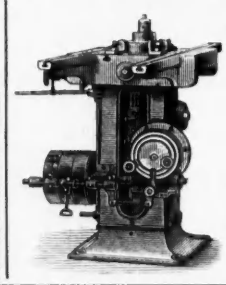

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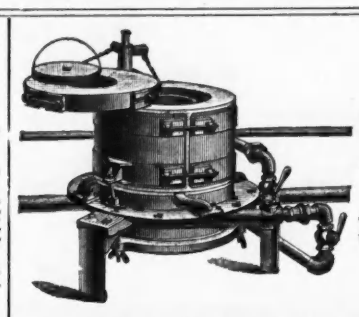

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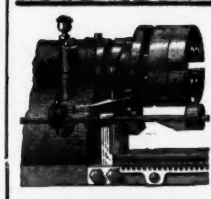

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Automatic Bolt-Threading & Nut Tapping Machine.
Made in all Sizes to Cut from 1-4″ to 6″.
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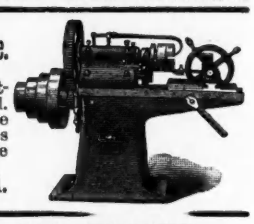

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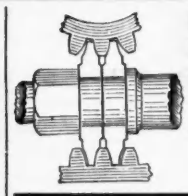

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to either start or stop machine.
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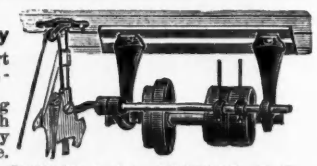

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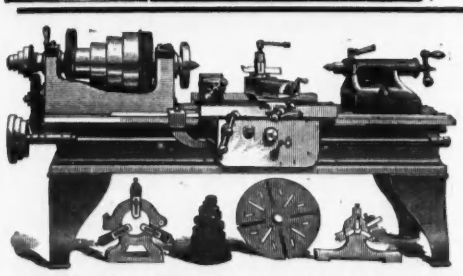

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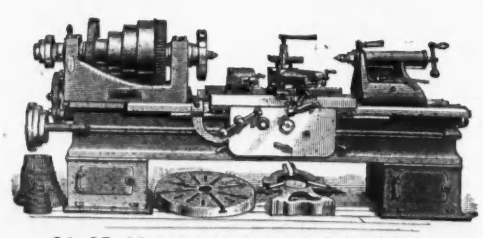

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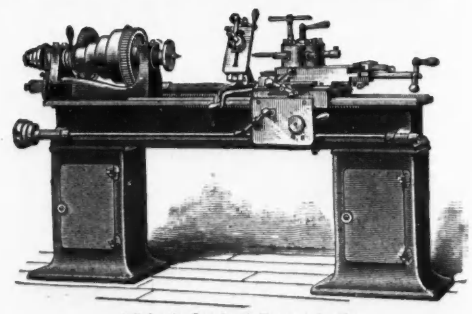

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Taper Attachment, Automatic Feed, Lever and Screw Movement, most complete brass lathe on the market.

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IRON PLANERS
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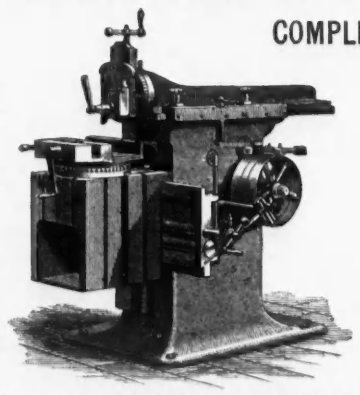
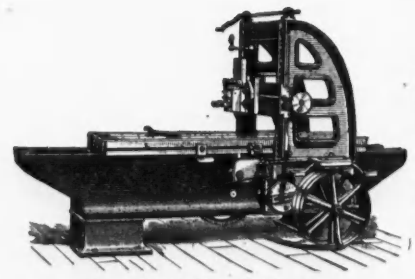
Stroke changed and adjusted while running. Stroke at all times positive. Invariably plane to a line. Detachable Tables.



20, 26 and 32-inch Triple Geared Shapers.
Stroke changed while machine is running. Shaft can be passed through head of machine and key seat cut in same to any length. Extra heavy vises. Tables slotted on all sides.



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Extra deep beds and tables. Powerfully geared. Plenty of Metal and designed for extra heavy duty. All Feeds and Shipper operated from both sides.
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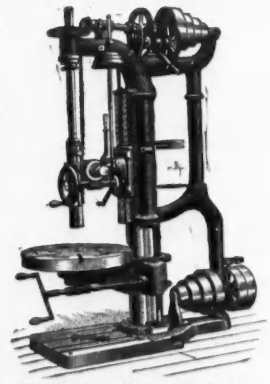

25, 28, 32 and 40-inch Drills.
Automatic stop to feed. Quick return on right side. Table operated from front. Large cones and long belts.

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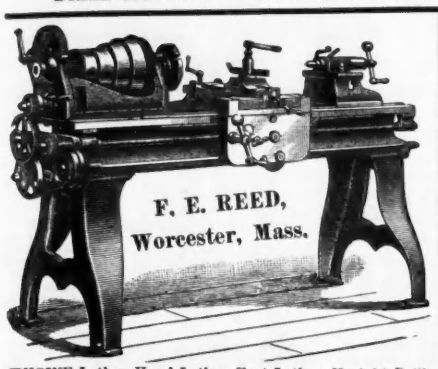

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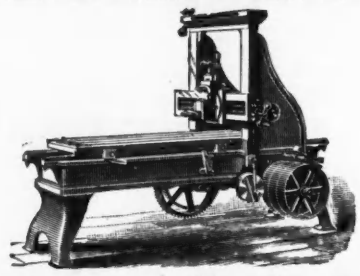

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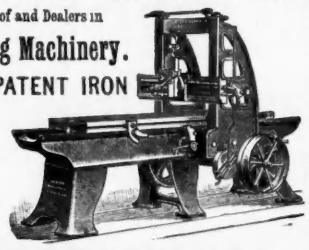

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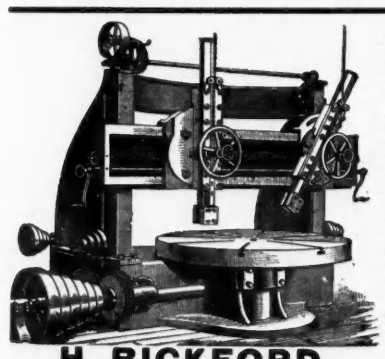

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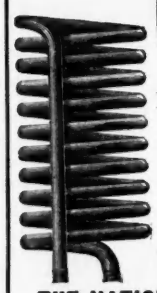

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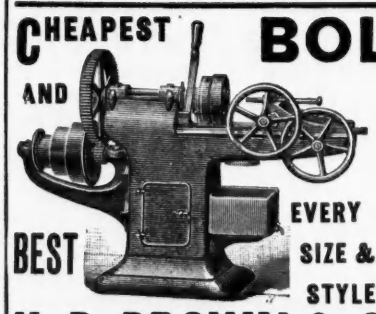

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Near Culvert,
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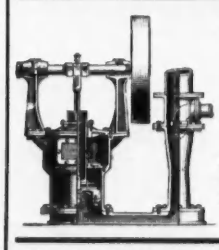

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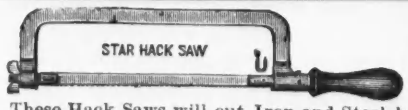

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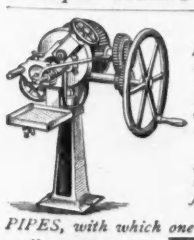

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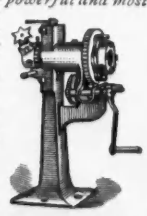

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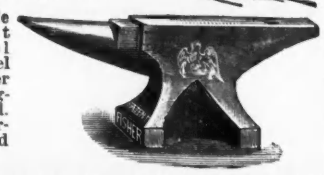

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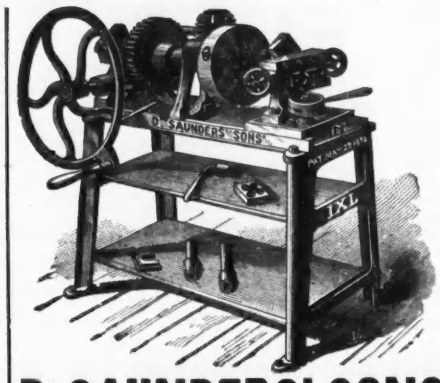

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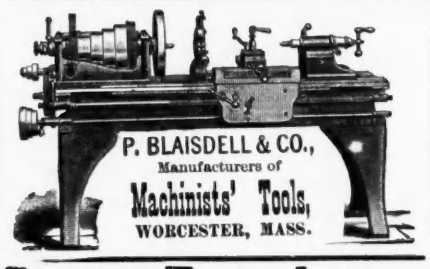

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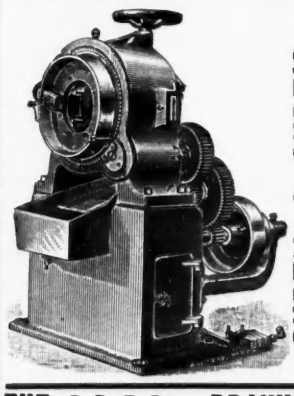

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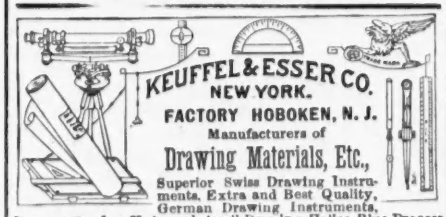

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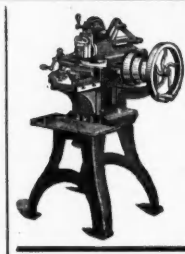

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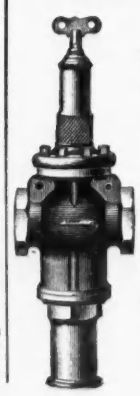

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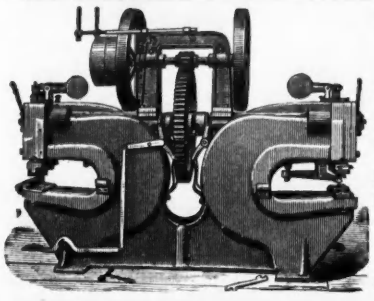

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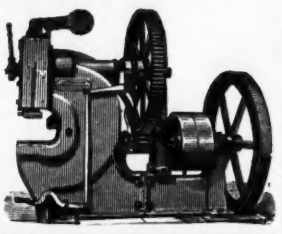

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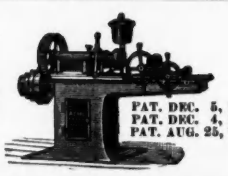

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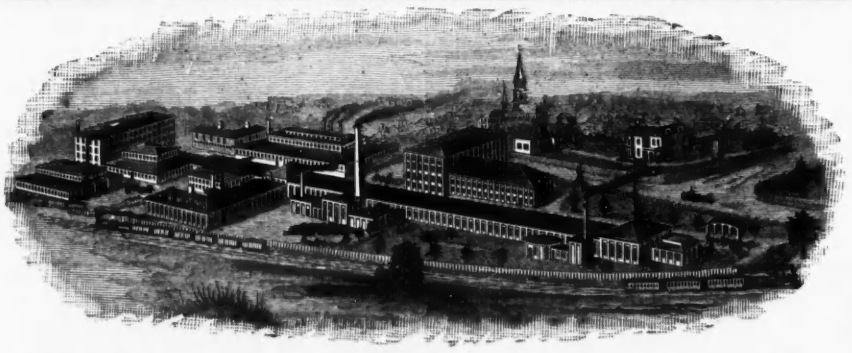

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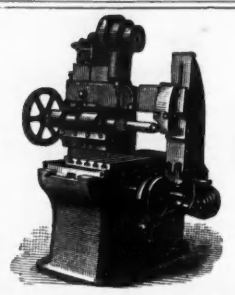

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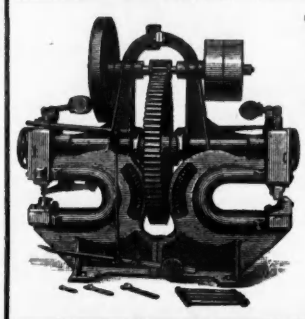

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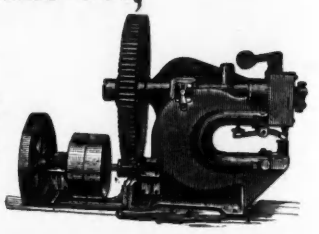

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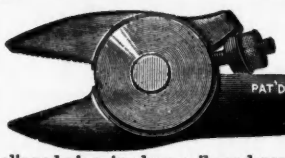

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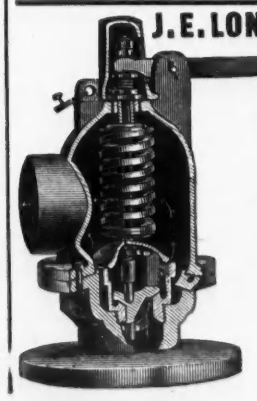

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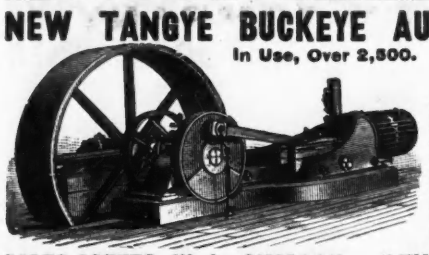

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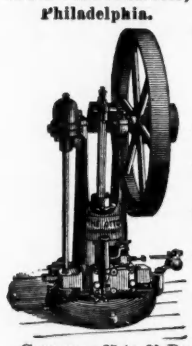

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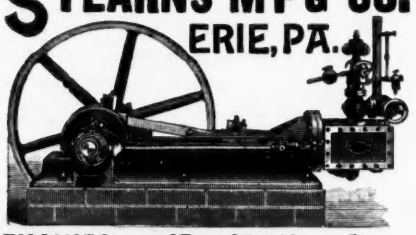

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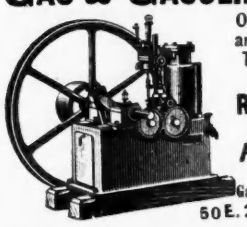

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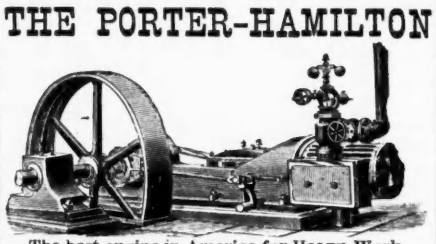

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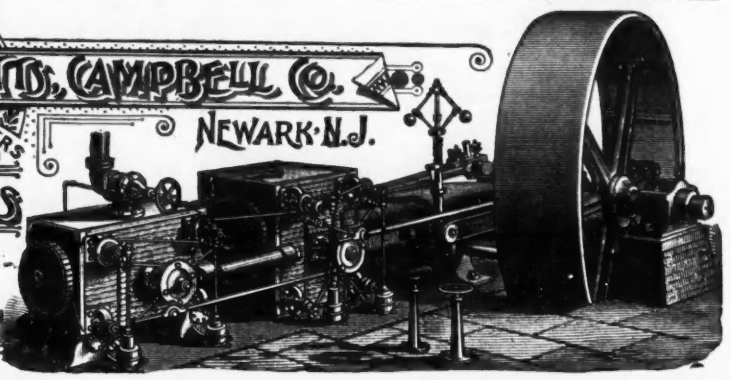

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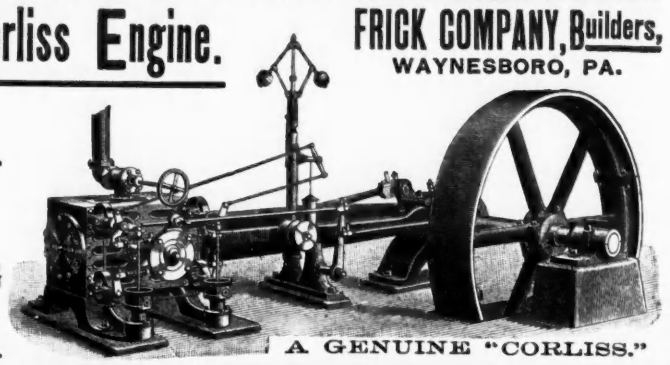

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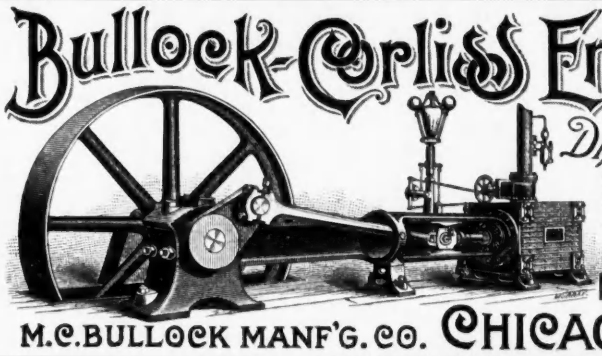

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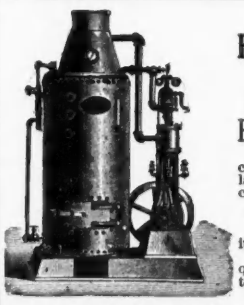

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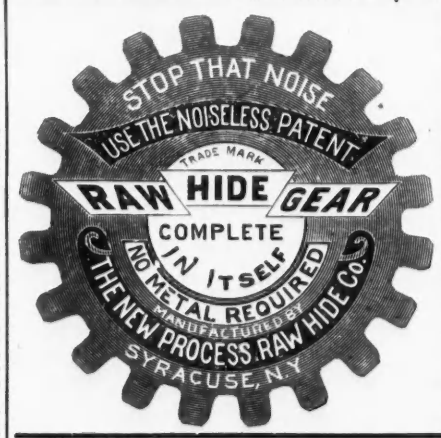

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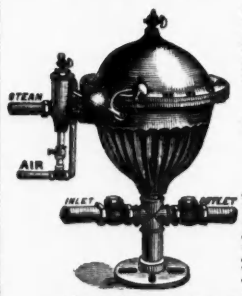

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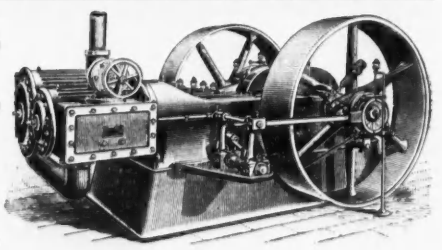

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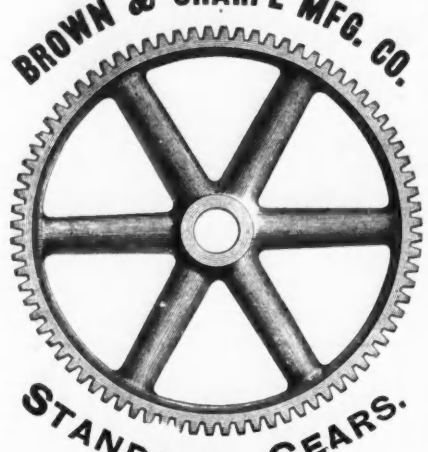

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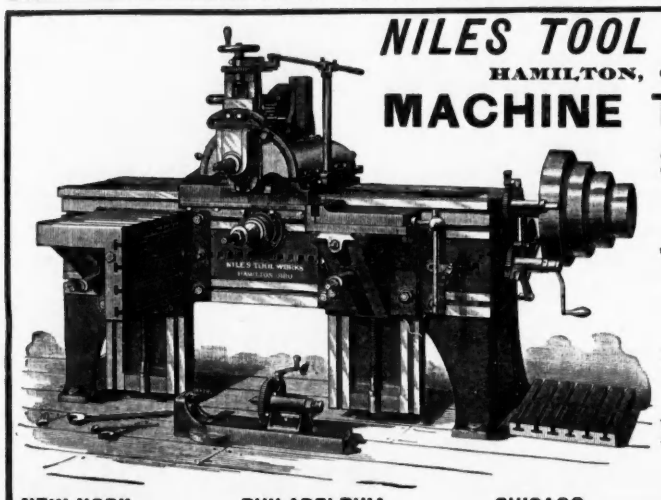

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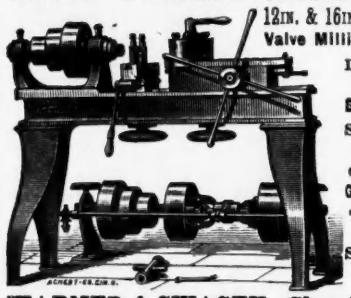

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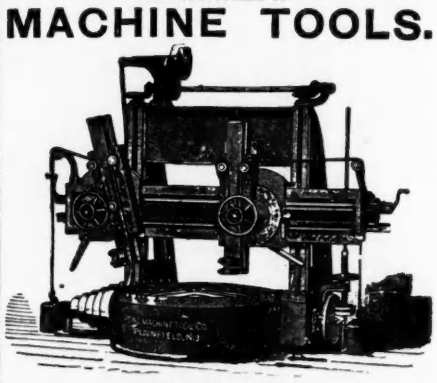

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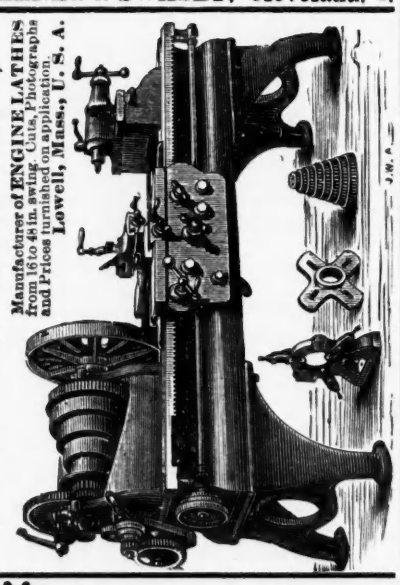

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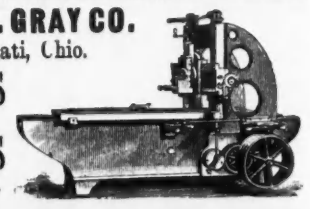

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